# FLIGHT

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*Club Secretaries and others desirous of announcing the dates of important fixtures are invited to send particulars for inclusion in this list:—*

**1932**

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**Mar. 26-28.** Mordant's Court Farm, Dunton Green, Air Display (Miss Pauline Gower).
**Mar. 30.** R.Ae.C. House Dinner and Annual General Meeting.
**Apr. 1.** Entries close at ordinary fees for King's Cup Race.
**Apr. 1.** Opening of Greek Aero Show, Athens.
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**Apr. 2-10.** National Aircraft Show, Detroit, U.S.A.
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**May 28.** Brooklands Meeting.
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**June 4.** Cardiff Flying Meeting.
**June 4.** Leicester Ae.C. Flying Display and Motor Gymkhana at Ratcliffe Aerodrome.
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**June 11.** Leicester Ae.C. Meeting, Desford.
**June 18** Hull Air Display.

# EDITORIAL COMMENT

CAPT. N. F. LAURENCE'S paper on "The Development of Naval Air Work," which was read before the Royal United Service Institution on March 18, was an extremely interesting and useful contribution to the study of aircraft's place in national defence. There are, we believe, some people who hold that between the Royal Navy and the Royal Air Force there lies a great gulf of animosity and mutual contempt. If a feeling of grievance still exists in certain naval circles that, though the Admiralty pays for the whole of the Fleet Air Arm, though all the observers are naval officers, and though many of the pilots and other ranks also belong to the Navy, still the Air Ministry retains control over the F.A.A. when it is not afloat, and has power to change the personnel, at least of those pilots who are not naval officers, we can well sympathise with that feeling. As we have often stated, we are not in favour of divided control and responsibility in warlike operations, and we believe in a clear line being cut between naval defence, military defence, and air defence. It would also make for clarity in explaining matters to the taxpayer, if the cost of the Fleet Air Arm did not appear in the Air Estimates even as an appropriation in aid. It swells the apparent volume of the Air Estimates, what are called the Gross Estimates, by the addition of a sum which entirely concerns naval defence. In the same way we are of the opinion that the cost of the School of Army Co-operation at Old Sarum and of the five army co-operation squadrons should be borne on the Army Estimates, as they too swell the Air Estimates, while adding nothing to the air defence of Great Britain, or of Iraq, or of the Middle East. That the Air Ministry is the best authority for deciding on the best type of aircraft for use in the Fleet Air Arm, and for placing the contracts for those aircraft with the manufacturers, we feel no doubt whatever.

**The Fleet Air Arm**

However illogical the organisation of the Fleet Air Arm may be, there is no doubt that on the carriers the feeling which exists between the naval and the R.A.F. personnel leaves nothing to be desired. That

naval officers can be firm believers in the value of aircraft in naval work was proved (if proof were needed) by the valuable paper read by the recent commander of a carrier, Capt. Laurence, D.S.O. He protested strongly against extreme views on either side, and was very wise in so doing. He mentioned the super-air-enthusiast who believes that a war can be won by bombing alone—attacks on enemy cities, destruction of public buildings, terrorising the civil population, in fact all that is comprehended in the word "frightfulness." Capt. Laurence said that he was not one of that school, and we agree heartily with him. No martial race has ever been beaten to its knees by frightfulness, and no war, we believe, will ever be won that way. The thought that British officers should discard all that goes with the ideas of humanity and civilisation, saving only the mechanical contrivances of destruction, is distasteful in the extreme; and there is all the evidence of history to prove that to do so would not achieve its object.

On the other hand, Capt. Laurence rather deplored the tendency in naval circles to take extreme views. He recalled the discomfiture of those who in ages past believed that new inventions, such as steam and the torpedo, would put an end to the ordinary operations of a fleet, and later he showed himself in opposition to the school of thought which unduly depreciates the utility of aircraft and of carriers. His lecture was, in fact, a plea for sanity and moderation in opinion. The Fleet Air Arm, he said, would in time find its proper place in the scheme of naval operations. It would not replace ships, and it would not replace guns, but it would be an extremely valuable addition to the resources of a fleet. This sanity and moderation of opinion is a great need of the times. We shall always have with us the extremists who expect too much from a new thing simply because it is new, and those who believe that no new thing can have any merits at all.

Capt. Laurence's belief in naval aircraft as they exist today was all the more striking because he undertook a defence of the naval authorities in the war for their disbelief in aircraft. The seaplanes of the time were certainly not very seaworthy craft, and we can understand that after a series of failures with them the naval officers lost faith in them, and in the seaplane carriers. Still, it does seem a tremendous pity that aircraft were not used more extensively at Jutland, when Admiral Jellicoe needed information above all things to prevent the escape of the German fleet. The sending up of one seaplane seems a dreadfully inadequate effort. The fact that the report which it brought was not forwarded on successfully to the flagship, and that what the seaplane saw was also seen and reported by some destroyers, did not prove that aircraft would have been of no further use. Of course, after the water got too rough for seaplanes, it was impossible to make further use of the *Engadine*; and the *Campania* with her ship-planes was not with the fleet. The question remains, was not the Admiralty paying the price for not having developed naval airships? During the actual battle of Jutland, it happened that the German Zeppelins proved only moderately successful. A report from a Zeppelin did finally send the German fleet home by the route which proved best for it, but this report was sent in error, the Zeppelin having made a mistake about some ships which it sighted. Still, with aircraft up overhead, there was always a chance of getting some all-important news, and without aircraft that chance did not exist. It is not open to the Admiralty at the moment to build airships for itself, but it is open for their lordships to demand of the Cabinet that the Air Ministry should carry on the development whenever national funds permit. We are not supposing that airships will again be able to take part in operations over the North Sea, but they might well prove most efficient and most economical in co-operation with cruisers in patrolling the ocean trade routes. We hope that the Admiralty is not making another error of omission which may cause the nation bitter regret in days to come.

Capt. Laurence did good service by bringing out with emphasis one point which should be obvious enough but is too often forgotten. Fights of the future will not be a case of warship *versus* aircraft, but of warship *plus* aircraft *versus* warship *plus* aircraft. The torpedo-planes, for example, will not have the simple problem of flying through a smoke screen, taking a chance with hurried and probably ineffective A.A. guns, and dropping their torpedoes within deadly range. If they bring off such an operation as that, it will be an example of a very successful and carefully-worked-out surprise. If the surprise element fails, both the smoke-layers and the torpedo-craft will have to evade the enemy's fighters, and their own fighters may not have sufficient range to come with them as escort. Ancillary arms have a way of cancelling each other out, despite a brilliant success now and then, and leaving the main issue to be fought out by the old mainstays, the battleship by sea and the infantry on land. We may be told that the tank has put an end to the infantry, but then it was once said that the torpedo had killed the gun. We do not profess to be military experts, or naval experts either, but we remain sceptical when we are told that any new weapon or device has abolished any of the old standbys of war. Each has made its appearance with somewhat bloated claims, and has ended by falling into its proper place as a valuable ancillary.

It was very interesting to hear Capt. Laurence's opinion that the carrier is to be considered as a warship, though not a battleship. It needs protection, but then he urged that the battleships also need protection. Their secondary armament is not sufficient to drive off an attack by a flotilla of destroyers. He did not deal with the charge that a carrier cannot keep up with a fleet because it must steam into wind whenever an aircraft takes off or lands. Perhaps it is not necessary that it should keep very close up. He did mention one point which has not always been taken into consideration when the value of carriers has been discussed, namely that the planting of a few bombs on the flying deck of each carrier would practically deprive the fleet of all its air arm. The only possible protection a carrier can have against air attack is through its own fighters, and they cannot count on preventing all bombers from getting through. That is rather a disturbing thought.

# The Avro 631 "Cadet"

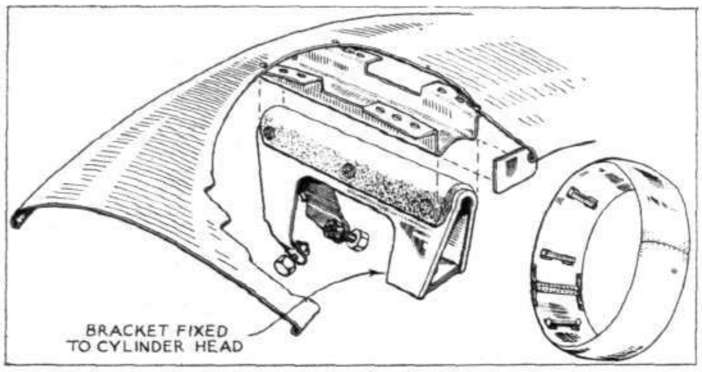
*Coming from a firm which holds a leading position in the production of training aircraft, the Avro "Cadet" will attract world-wide attention. It is a two-seater training biplane fitted with Armstrong - Siddeley 7-cylinder "Genet Major" engine of 135 b.h.p. It is designed for full training duties at low first cost and very modest maintenance cost*

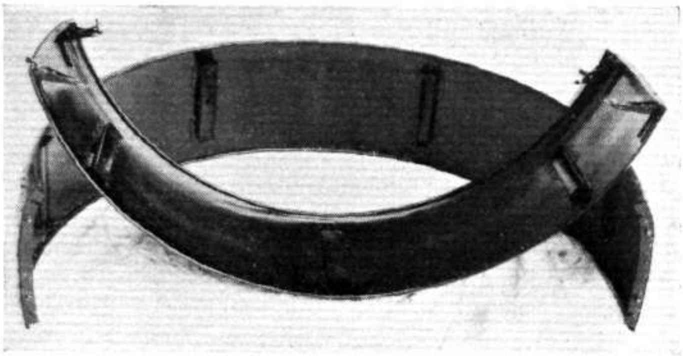
AT first sight is might appear that the production of the "Cadet" by A. V. Roe & Co., Ltd., represents a negation of that firm's policy. Actually this is not so. Those responsible for Avro policy have not changed their views in the slightest degree. The "Cadet" represents an addition to rather than an amendment of the policy. Our readers may recollect that in FLIGHT of July 3, 1931, the Avro firm contributed some very clearly expressed views on Air Force Training, in articles by Major F. P. Scott and Mr. R. J. Parrott. For the benefit of readers it may be recalled that in those articles the argument was used that in training aircraft true economy does not necessarily lie in low first cost, but that on the contrary it depends chiefly on other features, such as suitability for rapid all-through training in time of war, when there will be no time for advanced training following upon *ab initio* training, nor will there be war type aircraft available for such training, the machines being urgently wanted elsewhere. The Avro view, as expressed in those articles, was also that all-metal construction is essential, because of the difficulty in this country of getting suitable timbers in time of war, not to mention the longer life and lower maintenance cost of an all-metal aircraft.

In the Avro "Cadet" the question of first cost has been seriously studied, and all-metal construction has been abandoned. This is not because A. V. Roe & Co., Ltd., have changed their views, but because it is realised that while the above arguments hold good where large nations are concerned, there *are* countries in which cost is a very vital consideration, and in which local supplies of timber are plentiful, while facilities or experience in handling and repairing steel wings may be lacking. The Avro, like all other British firms, must study closely conditions abroad, and must rely to a great extent on a healthy export trade. It is with this in view that the "Cadet" has been produced.

In spite of a close family resemblance to previous Avro machines, the "Cadet," or Avro 631, incorporates a number of features not found in other Avro types, and these are obtained without any sacrifice of simplicity, which is, if anything, greater than ever. The machine is a normal single-bay tractor biplane, characterised by a

**REDUCING AIR DRAG: Behind the Townend ring is the exhaust collector ring, which in turn is separated by a large air space from the hemispherically-shaped nose of the fuselage. Note also the tripod undercarriage.** (FLIGHT *Photo.*)



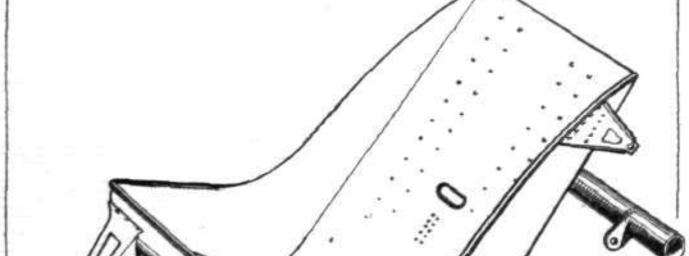
**EASILY DETACHABLE TOWNEND RING : Brackets fixed on the cylinder heads locate the ring, which is in two halves. On the ring are corresponding brackets, felt pads being interposed between the two brackets. Quick-release catches on opposite sides of the ring diameter can be undone in a few moments, and the two halves of the ring removed from the engine. The two halves of the ring are shown on the right.** (FLIGHT *Sketches.*)

very pronounced stagger. The engine is a 7-cylinder Armstrong-Siddeley "Genet Major" radial air cooled, and although the machine is to be marketed at a very reasonable price, such refinements as a Townend drag-reducing ring are fitted. That this has been worth while from a performance point of view seems clear from the fact that the top speed is no less than **118** m.p.h., while the initial rate of climb is **750** ft. per min. The lines of the "Cadet" are very pleasing indeed, and the machine is extraordinarily deceptive in that, although it has the wing span of the latest "Avians," its cockpits are as large as those of the Avro "Trainer." In spite of this, however, the fuselage does not look at all large for the size of the wings, and the general proportions are good and pleasing to the eye.

Designed specifically for complete flying training, from *ab initio* to advanced aerobatics, the "Cadet" has its two cockpits absolutely identical, so that when a pupil changes from front to rear cockpit his surroundings remain unchanged, and he knows instinctively where to put his hand on everything. The flying controls are of a very intriguing simplicity, obviously the result of much thought and scheming to get price and weight down, and the same may be said of nearly everything about the machine. The instruments are well placed, and the cockpits are of ample dimensions, so that there is plenty of leg, elbow and shoulder room everywhere.

Apart from the duplication of flying controls, instruments, etc., all engine controls are duplicated, as is also the tail trimming gear control, the latter in a most ingenious fashion. The notched quadrant in the front cockpit is the main "cheese cutter," but a somewhat similar control in the rear cockpit is linked up to it by Bowden cable, so that the tail setting can be effected from either cockpit.

By dropping the top longerons in the middle portion of the fuselage it has been possible to provide unusually deep



**SIMPLE SEAT SUPPORTS : No seat bearers are used, the seats being carried on two of the main structure cross tubes in the manner shown.** (FLIGHT *Sketch.*)

## AVRO 631 "CADET"

### 7-cyl. "Genet Major" Engine

*Dimensions*

| | ft. | in. | m. |
|---|---|---|---|
| Length o.a. | 24 | 9 | 7,55 |
| Wing Span (Top) | 30 | 0 | 9,15 |
| Wing Span (Bottom) | 30 | 0 | 9,15 |
| Height (Tail up) | 8 | 10 | 2,71 |
| Height (Tail down) | 8 | 9 | 2,67 |
| Chord (Both wings) | 4 | 9 | 1,45 |
| Wing Gap | 5 | 0 | 1,52 |
| Tail Plane Span | 9 | 9 | 2,97 |
| Airscrew Diameter | 6 | 6 | 1,98 |
| Airscrew Pitch | 4 | 9 | 1,45 |

*Areas*

| | sq. ft. | m.² |
|---|---|---|
| Main Planes (incl. ailerons) | 262 | 24,30 |
| Ailerons (Total) | 21·5 | 2,00 |
| Tail Plane | 19·7 | 1,83 |
| Elevators | 13·4 | 1,24 |
| Fin | 2·4 | 0,22 |
| Rudder | 10·2 | 0,95 |

*Weights*

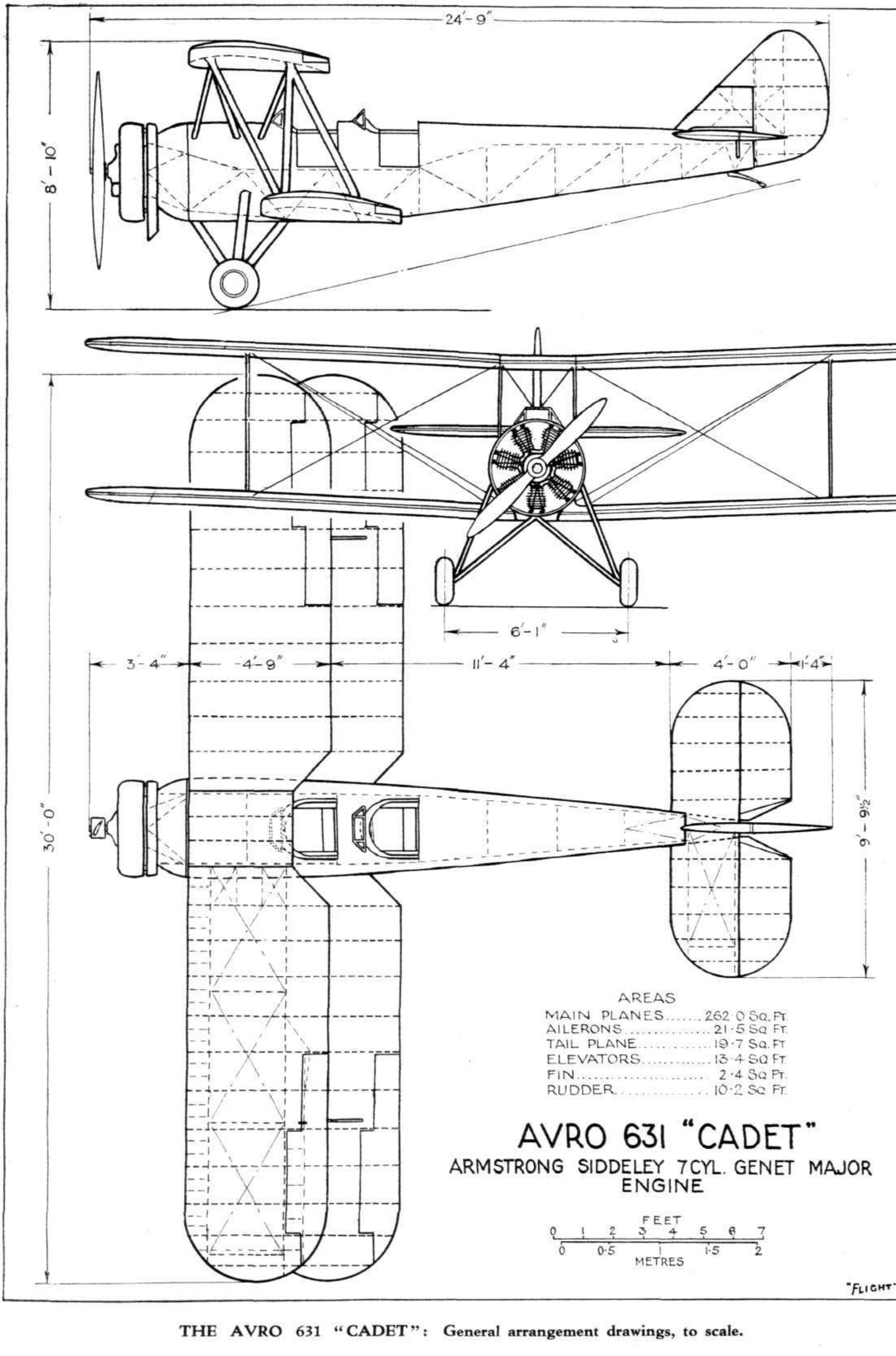
| | lb. | kg. |
|---|---|---|
| Wing Structure | 264 | 120 |
| Tail Surfaces | 38 | 17,3 |
| Undercarriage and Skid | 119 | 54,1 |
| Fuselage (complete with controls and instruments) | 302 | 137,3 |
| Power Plant | 443 | 202 |
| Tare Weight | 1,166 | 530,7 |

*Load*

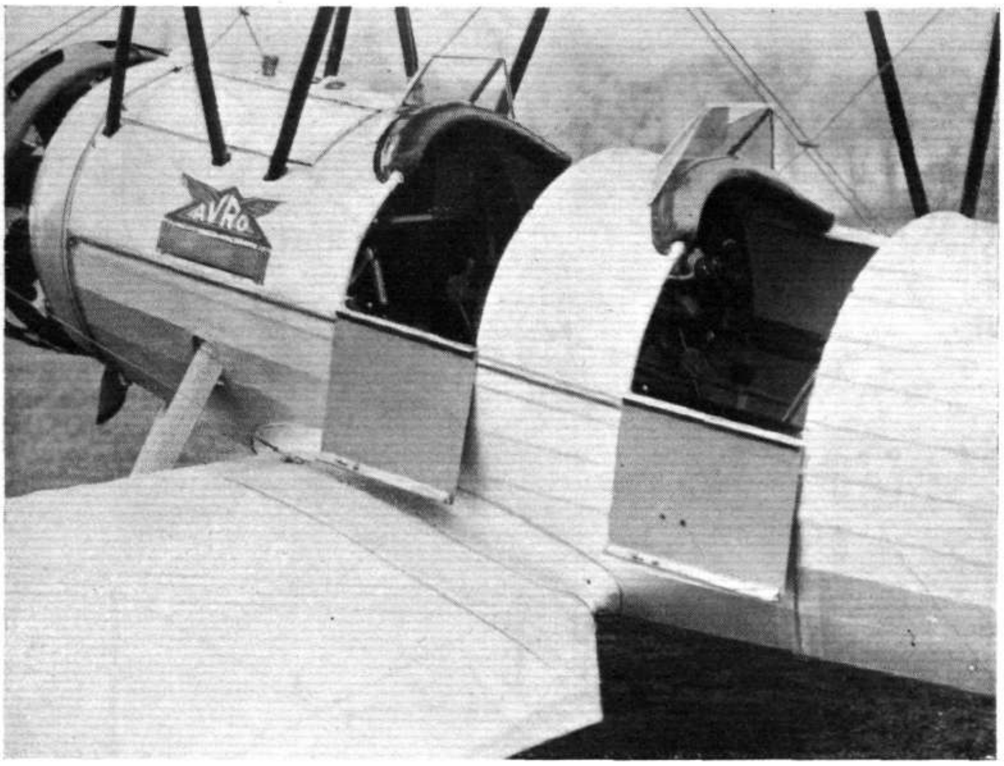
| | lb. | kg. |
|---|---|---|
| Pilot and Parachute | 190 | 86,4 |
| Pupil and Parachute | 190 | 86,4 |
| Fuel (28 galls. = 127 litres) | 219 | 99,5 |
| Oil (2·8 galls. = 12,7 litres) | 28 | 9,9 |
| Total Load | 627 | 282,2 |
| Gross Weight | 1,793 | 812,9 |
| Wing Loading | 6·85 lb./sq. ft. (33,5 kg./m²) | |
| Power Loading | 13·25 lb./h.p. (6,02 kg./CV.) | |

*Performance*

| | m.p.h. | km./h. |
|---|---|---|
| Maximum speed near Ground | 118 | 190 |
| Speed at 5,000 ft. (1 525 m.) | 112 | 180 |
| Speed at 10,000 ft. (3 050 m.) | 105 | 169 |
| Cruising speed at 1,000 ft. (305 m.) | 100 | 161 |
| Minimum speed | 45 | 73 |
| Rate of Climb (Ground level) | 750 ft./min. (3,8 m/sec.). | |
| Time to 1,000 ft. (305 m.) | 1 min. 22 sec. | |
| Time to 5,000 ft. (1 525 m.) | 8 min. 12 sec. | |
| Time to 10,000 ft. (3 050 m.) | 21 min. 48 sec. | |
| Time to 12,500 ft. (3 800 m.) | 35 min. 54 sec. | |
| Service Ceiling | 13,000 ft. (4 000 m.). | |
| Absolute Ceiling | 15,000 ft. (4 575 m.). | |
| Duration at cruising speed | 3½ hours. | |
| Range at Cruising Speed | 350 miles (564 km.). | |




**THE AVRO 631 "CADET": General arrangement drawings, to scale.**



EASY ENTRY AND EXIT : By dropping the top longerons of the fuselage, the cockpit doors can be made very deep, and both passengers can readily escape by parachute in case of emergency. (FLIGHT *Photo.*)

cockpit doors, which make it very easy to get into and out of the cockpits. The great degree of wing stagger, and the attachment of the rear lift wire to the front lower spar root, result between them in a particularly unhindered exit from the front cockpit, so that the occupant of this should have no more difficulty in jumping out with his parachute in case of emergency than the man in the rear cockpit. In a machine capable of stunting, and indeed designed for aerobatics, this is a point of very great importance.

Controllability and manœuvrability are other very desirable features in a training machine, and these are present in full measure in the Avro "Cadet." The aileron control is particularly effective, even at very low speed, and with the Bristol-Frise balance the ailerons are comfortably light in operation. They are fitted to top and bottom planes, but the balance extends over a relatively small proportion only to avoid over balancing.

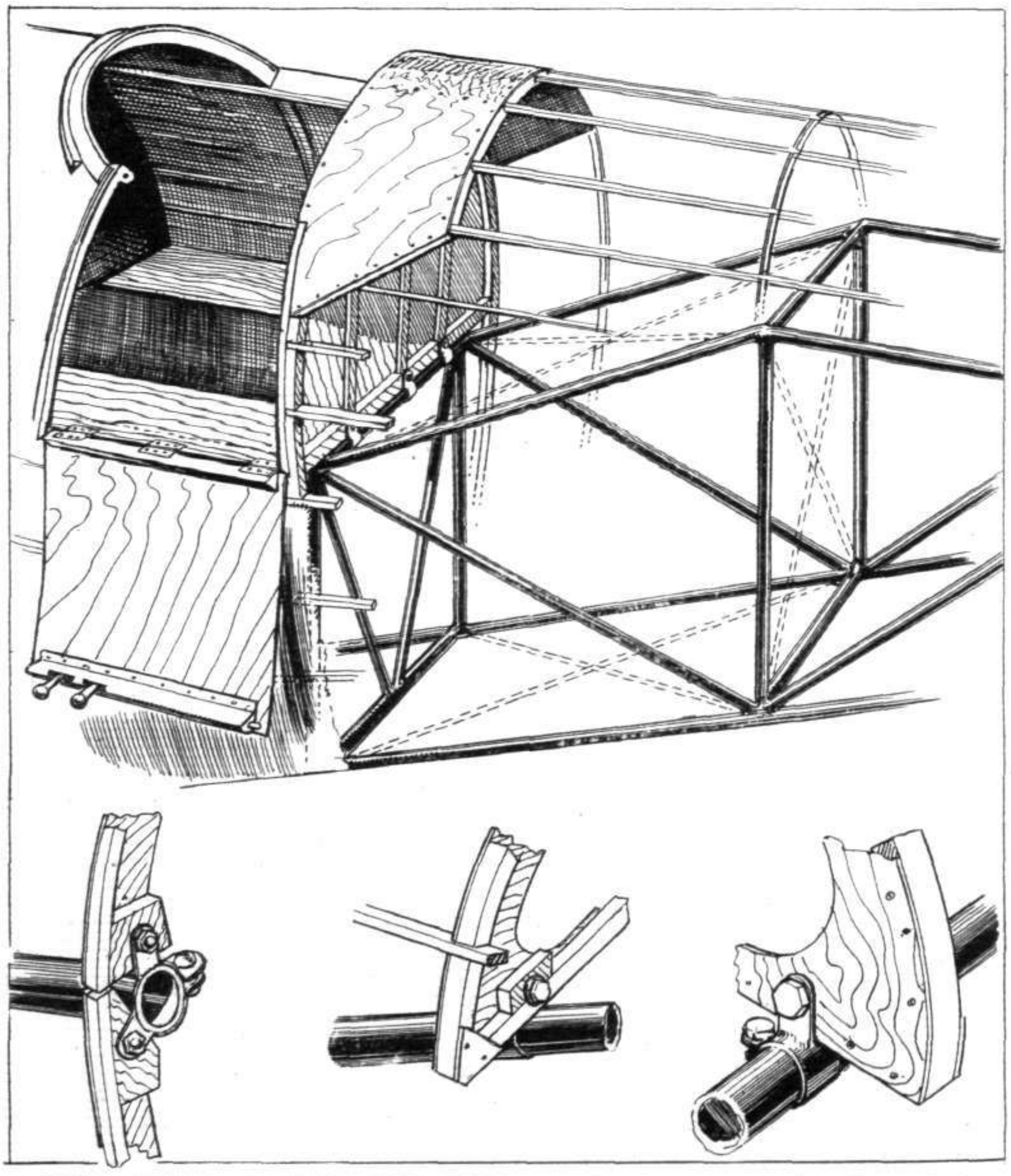
In a machine designed for school work, and which therefore will be called upon to make a very large number of landings, the undercarriage is often the deciding factor in the durability of a machine. In the "Cadet" Mr. Chadwick has introduced a somewhat novel type of telescopic leg, in which coil springs are placed end to end, although actually working in parallel. The shock absorbing qualities are quite remarkable, and it would take a very bad landing indeed to cause serious damage to the structure.

### The Structure

With a view to cheapness, and also because in several foreign countries timber is available in good qualities, the Avro "Cadet" has been made of composite construction, *i.e.*, it has wooden wings and a welded steel tube fuselage.

The wings, which are of modified T.64 aerofoil section, are of normal wood construction, with I-section spindled spars and plywood ribs. The ailerons are of the Bristol-Frise type, and are fitted to upper and lower wings, but have been modified by extending the balance over a portion of them only, so that over balancing does not occur. A further advantage of this particular arrangement of the balance is that the leads from ailerons to control column become very straightforward indeed. The wing tips are rounded in plan form, and the overhanging portions are fined down to a thin edge.

The fuselage is of the type of welded construction which Avros have employed for a considerable time, and is so well known that it will need no detailed description here. It will suffice if we recall briefly that the top and bottom longerons are connected by a series of diagonal struts, the



SOME FUSELAGE DETAILS : Welded steel tube construction is used for the main structure of the fuselage. The top longerons are dropped in the centre portion to give deeper cockpit doors. The secondary structure is of wood, and attached to the primary structure by simple clips. (FLIGHT *Sketches.*)

joints being made by welding the strut ends to the longerons, and the few bracing wires used being looped over tubular quadrants welded into the corners. The welded construction has facilitated the dropping of the top longerons to give deeper cockpit doors without making these a part of the primary structure. The outside form of the fuselage is given by spruce stringers carried on light skeleton wooden formers attached to the primary structure by simple clips. The fuselage covering is fabric, and in order to facilitate inspection the fabric is secured in appropriate places by "Zipp" fasteners. Normally the tags of the fasteners are locked by a small length of thin wire, but when this is removed the fasteners can, of course, be undone in a few seconds, and the interior structure examined.

The Armstrong-Siddeley 7-cylinder "Genet Major" engine is mounted on a circular plate, which is in turn supported on four steel tube vees, the apices of which are secured to the forward ends of the longerons. This type of mounting has been found to resist torque reaction very well, and has the further advantage of making the back of the engine very accessible.

By placing the petrol tank (capacity **28** gallons) in the deck fairing forward, the top centre section is kept thin, a fact which adds to the clean appearance of the machine. The oil tank is slung on straps on the fireproof bulkhead behind the engine.

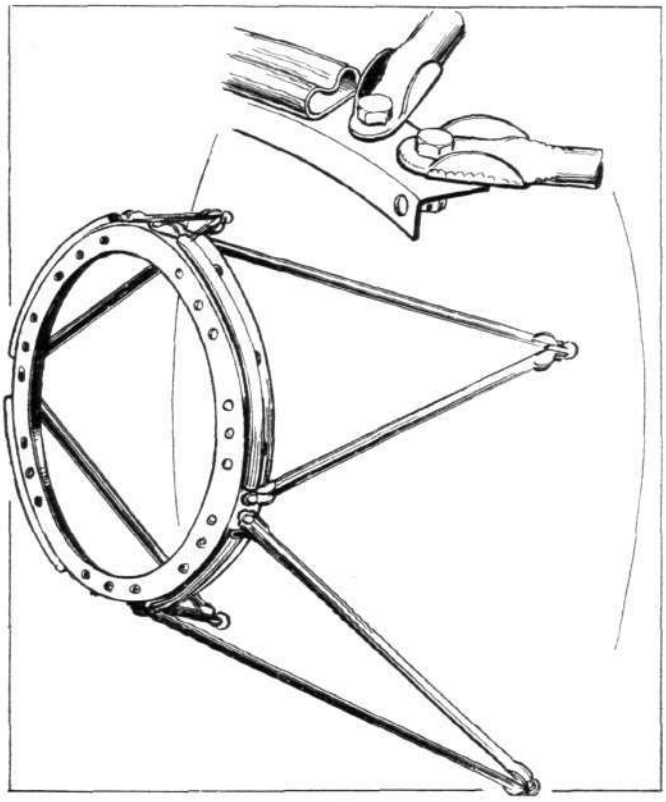
A very neat Townend ring has been designed for the "Cadet." As it promises to be very successful, it may be assumed that a similar principle will be applied to other Avro types. The ring is built in two halves, held together by quick-release devices. The ring is supported on the engine by fitting brackets on top of the cylinders, these brackets corresponding with other brackets on the cowling ring. The brackets serve merely to locate the ring, which is not bolted or otherwise attached to the engine direct. By interposing a felt pad between the engine brackets and their corresponding cowl brackets, rattle is eliminated, and the amount of vibration transmitted from the engine to the ring is negligible. The arrangement has the very great advantage that the time taken in removing or replacing the cowl is a few minutes only, and the engine is for practical purposes as accessible as an uncowled engine.

The main data of the Avro "Cadet" are given in the table on page **254**. From this it emerges that the ratio of gross weight to tare weight is 1.62. At first this may appear to be a somewhat low value, but it should be realised that the ratio is based on the gross weight corresponding to "Aerobatics" Certificate of Airworthiness. A considerably greater load could be carried for "Normal" C. of A., when the ratio becomes rather higher than the average.

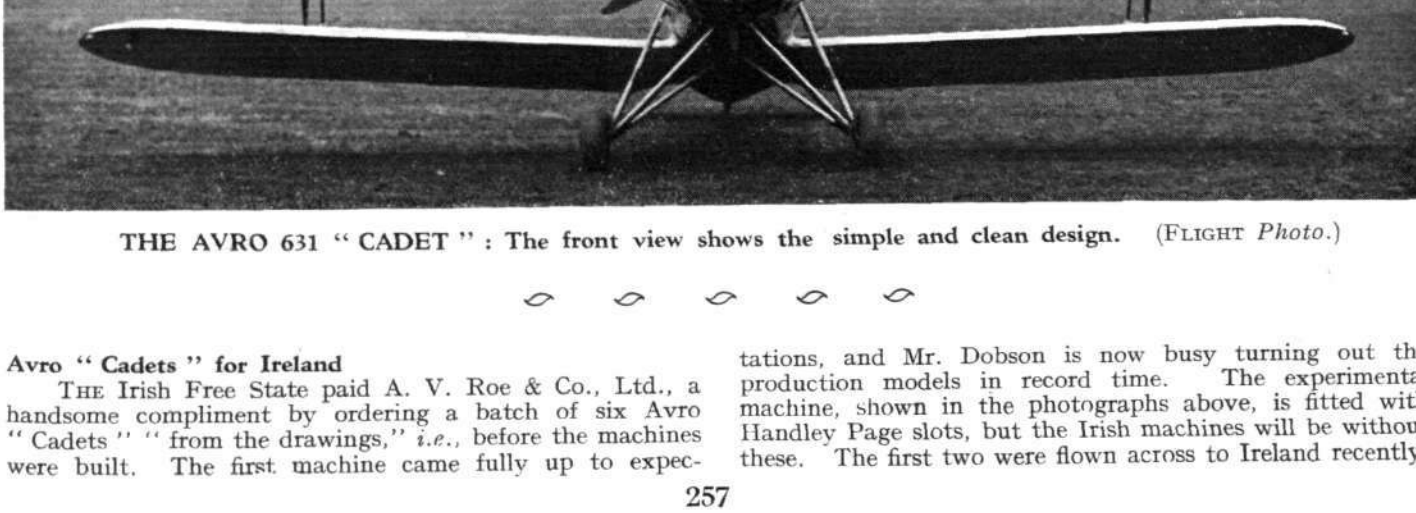
Aerodynamically the "Cadet" appears to be very efficient, the Everling "High-speed Figure" $\eta : 2k_0$ being no less than 21.7, which points to a low minimum drag coefficient.

The speed range is from **45** to **118** m.p.h., a ratio of 2.62 to 1, and the initial rate of climb is **750** ft./min., all of which point to efficient aerodynamic design in proportion to the wing loading and power loading.

Altogether the Avro "Cadet" is to be regarded as a very attractive training aircraft, and in spite of its relatively low power (**135** h.p.) and sturdy construction, it has a performance which should make it suitable for full flying training, without the need for further training on high-power types.



**THE ENGINE MOUNTING : The ring supporting the "Genet Major" engine is carried on four steel tube vees, the apices of which pick up the ends of the four longerons. The curved tube on the ring, shown in the inset, locates the cowl-securing cable.** (FLIGHT *Sketch*.)



**THE AVRO 631 "CADET" : The front view shows the simple and clean design.** (FLIGHT *Photo*.)

**Avro "Cadets" for Ireland**

THE Irish Free State paid A. V. Roe & Co., Ltd., a handsome compliment by ordering a batch of six Avro "Cadets" "from the drawings," *i.e.*, before the machines were built. The first machine came fully up to expectations, and Mr. Dobson is now busy turning out the production models in record time. The experimental machine, shown in the photographs above, is fitted with Handley Page slots, but the Irish machines will be without these. The first two were flown across to Ireland recently.

# *Air Transport*

## The Breda 32 Commercial Monoplane

### An Interesting Italian Machine With Good Structural and Aerodynamic Features

FROM every point of view the type 32 commercial monoplane recently produced by Societa Italiana Ernesto Breda, of Milan, is a very interesting aircraft. Aerodynamically it is characterised by exceptionally clean design, and structurally it incorporates features which make for lightness. From the operator's point of view it should have much to recommend it, as it carries a reasonably good pay load at a fairly high cruising speed over a range sufficient for most purposes. More specifically, the Breda 32 is a low-wing cantilever three-engined monoplane of all-metal construction, the expression all-metal being in this case literally true, as the covering is of metal. The gross weight is 14,300 lb., the engine power 960 b.h.p., and the wing area 915 sq. ft. As the maximum speed claimed is 147 m.p.h., the Everling "High-speed Figure" $\frac{\eta}{2k_D}$ reaches the high value of 20.6, which must be regarded as very good indeed for a three-engined aeroplane, and indicates that the minimum drag coefficient of the whole machine is very low, so that the impression given from the front view on the next page is in this case in accordance with actual aerodynamic facts. Unfortunately this is not always so. If one assumes a propeller efficiency of $\eta = 0.75$ the minimum drag coefficient, or at any rate the drag coefficient corresponding to maximum speed, which is near enough the same thing, becomes 0.018 in British "absolute" units.

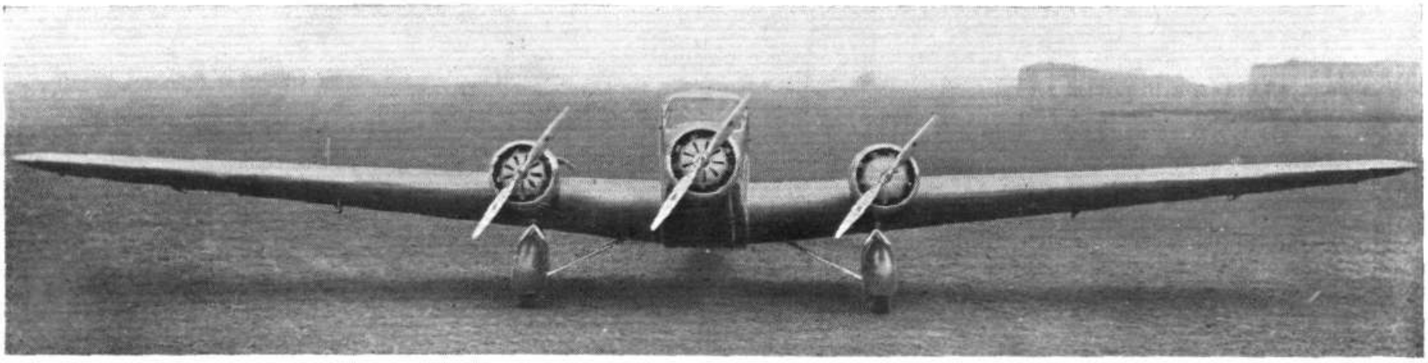
Of the structural details of the Breda 32 more will be said later. At present it will suffice if we point out that the gross weight of the machine is 14,300 lb. and the tare weight 8,360 lb., so that the ratio of gross to tare weight is 1.71, which must be considered good for a cantilever monoplane. In other words, the machine carries as disposable load 71 per cent. of its own weight.

Operationally the Breda 32 may be described by saying that it carries a total disposable load of 6.2 lb./h.p. at a cruising speed of 131 m.p.h. The allocation of this load may, of course, be in any proportion desired by the operator. Normally the machine has tankage for 2,310 lb. of petrol, giving a range at cruising speed of 840 miles. With its normal crew this tankage leaves a pay load of 2,981 lb., which corresponds to a pay load of 3.125 lb./h.p. For a cruising range of 840 miles this is quite a good figure, and indicates that the machine should be fairly economical to operate, especially taking into account that its performance is above the average for Europe.

Basing the design on a cruising range of 840 miles, the cabin has accommodation for 11 passengers. If one assumes an average weight per passenger of 180 lb. there is still left 1,000 lb. of pay load, either in the form of luggage (nearly 100 lb. per passenger) or freight or mails. This fact puts a slightly different complexion on the apparently high horse-power (87) per paying passenger.

In external appearance the Breda 32 resembles the Junkers machines. In fact, it is difficult, not to say impossible, to build a low-wing cantilever monoplane which does not resemble a Junkers. In detail construction, however, there is little or no similarity. The cantilever wing, of all-metal construction, is set on the fuselage at a pronounced dihedral angle to give lateral stability, and

**THE BREDA 32: View inside the cabin, looking aft. The central seats tip up to afford passageway for the other passengers. This feature is not likely to appeal to the majority of travellers.**



**CLEAN DESIGN: Front view of the Breda 32 showing the absence of excrescences.**

lateral control is ensured by ailerons of large span (approximately one-half of the wing span). The ailerons have their hinge line so arranged as to give a certain amount of aerodynamic balance, thus reducing the force which the pilot has to apply to the control wheel. The tail surfaces are of orthodox aerodynamic design, with horn balances for rudder and elevators.

Considerable care has been taken in producing the lines of the fuselage. The slope of the decking in front of the cockpit, and the angle of the windscreens, is such as to give as smooth a flow as possible while yet retaining a good view for the pilots. That the view is good in spite of the cowled central engine in the nose of the fuselage is indicated by the photograph on the next page.

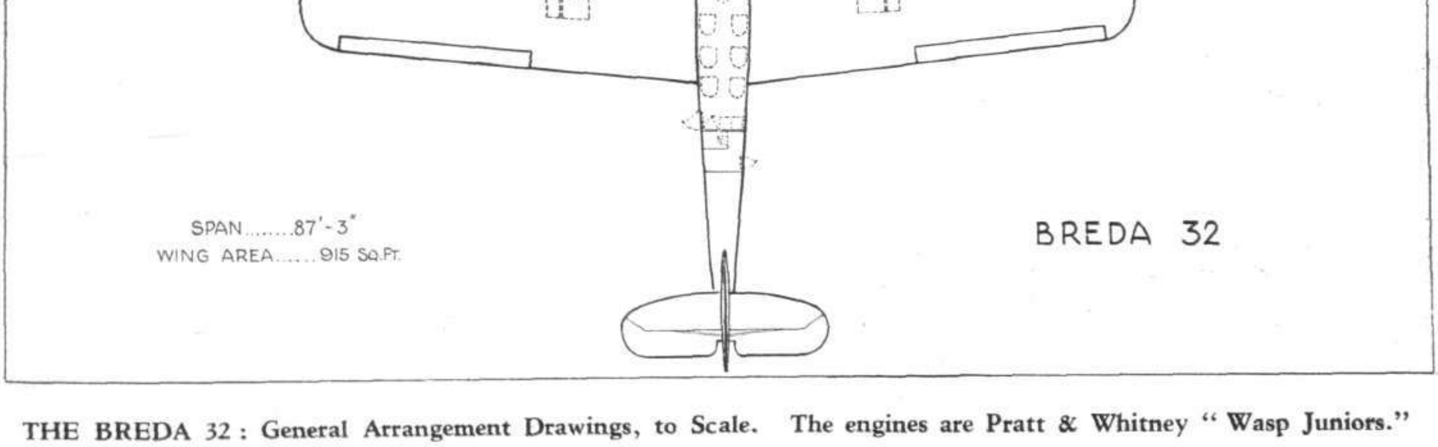
In the placing of the wing engines much thought has also obviously been expended. The wing engines are placed on a level with, but well ahead of the leading edge of the wing, and the engine mountings have been very carefully faired into the wing so as to cause as little disturbance to the air flow as possible. The low-drag engine cowlings may be assumed to smooth the flow over the engine nacelles so that here again everything possible has been done to reduce drag, while the fact that the airscrews are well away from the leading edge should make for smooth working and a minimum of interference.

The outboard engines are arranged with their axes at a slight angle (in plan view) so as to direct the slipstream on to the fin and rudder. This arrangement also is of some assistance when one of the wing engines is out of action in that it slightly reduces the turning moment and makes the rudder more effective.

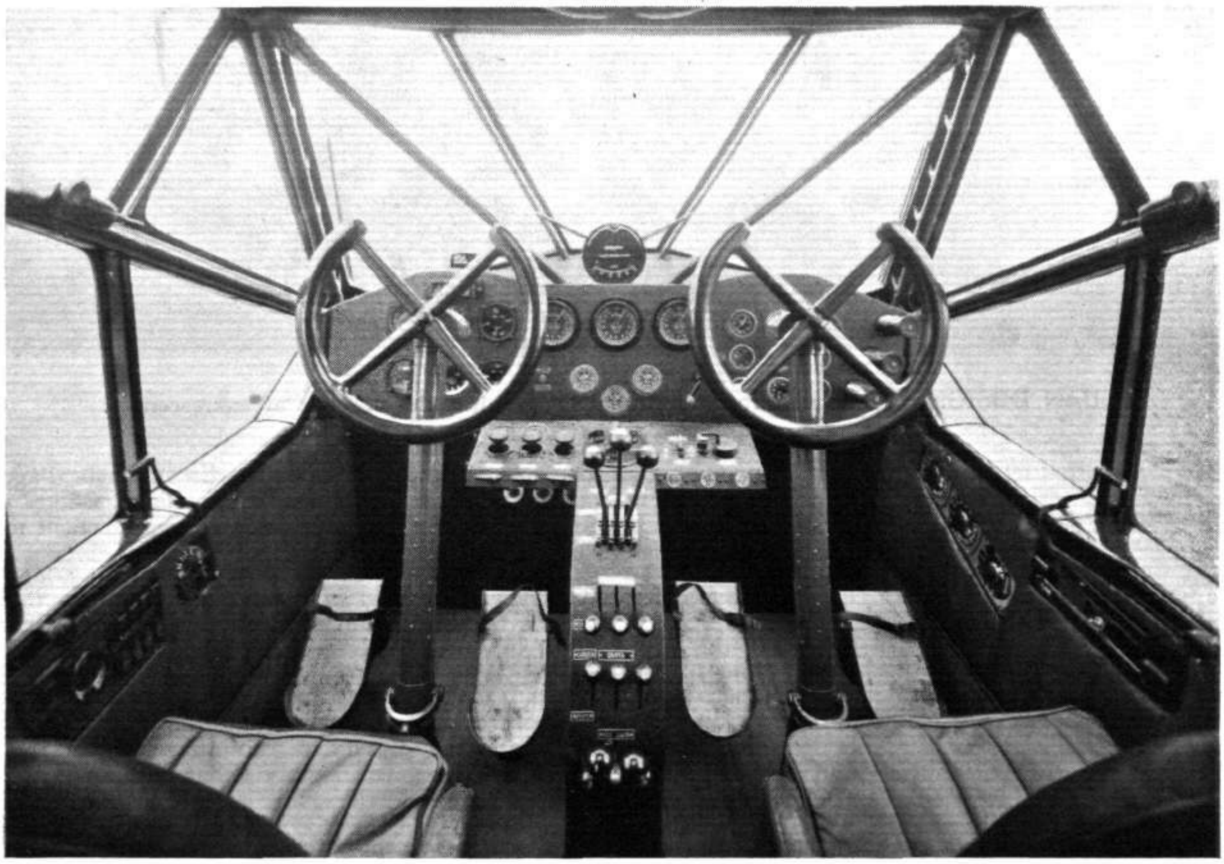
The undercarriage consists of two large wheels, each placed under its wing engine, and the wheels are partly enclosed in "spats" to reduce air drag to a minimum. The telescopic struts of the undercarriage are housed inside the leading edge of the wing, and only the forks carrying the wheels are exposed. A single diagonal strut braces each wheel against lateral loads. Brakes are fitted, and a castoring tail wheel which gives excellent manœuvrability on the ground.

The fuel is carried in tanks in the wing, one tank on each side, outboard of the wing engines, so that all fuel is well removed from the cabin and the fire risk should be very small. As a further precaution against fire, the petrol tanks are so arranged that the fuel can be quickly jettisoned, each tank having a jettison valve which is under the control of the pilot. In addition to the two main tanks there are two gravity petrol tanks, and in the event of failure of the petrol supply a hand pump is provided by means of which the pilot can keep the gravity tanks supplied.

The cabin of the Breda 32 measures 14 ft. in length, 7 ft. in height, and the average width is 6 ft., giving a volume of about 590 cu. ft., which corresponds to about 53½ cu. ft. per passenger. The seats are arranged in a somewhat unusual manner. Along each side of the cabin are three seats in line fore and aft. Against the back wall of the cabin is a sofa seat for two, making eight in all. If the machine is filled to capacity, however, it is necessary to take into use the three tip-up seats placed between the side seats. The occupants of the tip-up seats take their places last, of course, and when they are *in situ* they and all the rest of the passengers except the two in the sofa are there for good. No walking about is possible. The arrangement is not one that would appeal to the majority of passengers on the London-Paris route. Air sickness is not an unknown ailment, and restricting the movement of the passengers in this way seems to be quite out of keeping with the otherwise excellent planning of the Breda 32. It may, of course, be that the machine is intended for routes on which a full complement of passengers will rarely be carried, in which case the objection




**THE BREDA 32: General Arrangement Drawings, to Scale. The engines are Pratt & Whitney "Wasp Juniors."**



**DUAL CONTROL : The pilots' cockpit not only affords an excellent view, in spite of the fuselage engine, but the arrangement of controls, instruments, etc., appears to have been given a good deal of thought.**

does not arise, but the practice of rendering immobile passengers in an aeroplane designed to have a cruising range of 840 miles (or some 6½ hr.) is not one to be commended.

In other respects the cabin of the Breda 32 appears to be in keeping with modern ideas. The windows are made to open, and in winter the cabin is heated by air from a muff around the exhaust pipe of the central engine.

The pilots' cockpit is uncommonly well appointed, with two upholstered armchairs side by side, and the controls, instruments, etc., carefully arranged to be within reach and sight of both pilots. Behind the pilots' seats are two smaller armchair seats intended for the engineer and wireless operator. A crew of four for a machine carrying only 11 passengers may appear excessive, but presumably on some routes the crew can be kept down to two, and the other two seats used in an emergency for passengers.

*(To be concluded.)*

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**The Proposed Arctic-Atlantic Air Route**

The consent of all the Governments concerned has now been secured for the establishment of the regular passenger and mail air service from Copenhagen to Canada, via the Faroe Islands, Iceland, and Greenland, to which we have referred in previous issues of Flight.

**Imperial Airways' Mediterranean Tour**

Imperial Airways are now offering a Mediterranean tour of 16 days' duration, which certainly sounds extremely fascinating. After the usual journey by landplane and train to Brindisi, the passenger embarks on a "Kent" flying boat (four "Jupiter" engines) and flies off by the beautiful Dalmatian coast to Athens. The view of the capital of modern Greece and the ancient intellectual capital of the world, as seen from the air, and from many different angles as the boat glides down to land, must in itself be worth much voyaging to enjoy. The next stage takes the traveller to the Sea of Galilee, and several days are spent in Palestine. The tourist can visit (say) Jerusalem, Damascus, and the desert city of Petra. The eighth day takes the traveller to Cairo, where four days are spent. On the 12th day the evening train is taken to Alexandria, and the passengers again embark on a "Kent" and fly back via Crete and Athens to Brindisi. The charge while travelling with Imperial Airways, including hotels, meals, railway connections, and motor-cars, is £80. The extras are what the traveller likes to spend on excursions in Palestine and Egypt. The next time that we find a spare £80 lying about in our overdraft—well, we can imagine no better way of getting rid of it than by a tour in a "Kent."

**Graf Zeppelin Starts a Busy Season**

Shortly after midnight, March 20-21, the German airship *Graf Zeppelin,* with a crew of 44, nine passengers and mail, left Friedrichshafen on the first of the ten flights to Pernambuco, Brazil, and back, she has been scheduled to make this year. The airship was reported going well over Gibraltar and Tangier on the afternoon of March 21.

The Postmaster-General announces that this service by the *Graf Zeppelin* from Germany to South America will be available for specially superscribed correspondence from this country at the same charges as those for the existing air service, namely:—To Brazil: Letters and postcards, 3s. 6d. per ½ oz.; printed papers, samples, etc., 10d. per ½ oz. To Argentine, Bolivia, Chile, Paraguay and Uruguay: Letters and postcards, 4s. per ½ oz.; printed papers, samples, etc., 1s. per ½ oz. Correspondence intended for despatch by this route should be, in addition to the blue air mail label, the inscription "By Graf Zeppelin."

**Far East Flight Dinner**

A reunion dinner of the officers of the R.A.F. Far East flight, which travelled from Plymouth to Australia and back to Singapore in four Southampton flying boats, and subsequently became No. 205 (F.B.) Squadron, was held on March 18 at the Royal Air Force Club, London. All the officers of the flight were present except Sqd. Ldr. G. E. Livock, who was detained on duty. There were present Air Com. Cave-Browne-Cave, Sqd. Ldrs. P. Maitland, S. Freeman, D. V. Carnegie, T. McClurkin, Flt. Lts. H. G. Sawyer, G. E. Nicholetts, B. Cheesman, L. Howard, and Mr. S. D. Scott (now with Saunders-Noe, Ltd.). Mr. Mitchell, of the Supermarine firm, and Mr. Wilkinson, of the Napier firm, were guests of the officers.

# The AIRCRAFT ENGINEER

FLIGHT ENGINEERING SECTION

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CONTENTS



## "WIRES CUT" CASES IN WING STRUCTURES.

By A. E. Russell, B.Sc., A.F.R.Ae.S.

*A broken lift wire sounds rather terrifying, and by calculations based on the usual assumption of ignoring redundant incidence bracing, the loads found in the centre section are certainly very severe. Very few aeroplanes in existence could have a factor of safety of even 1 under these loads. The fact that many hundreds of wires have broken in the air without disaster shows that normal assumptions do not give results approaching the true state of affairs.*

*Mr. A. E. Russell, who is head of the Stress Department of the Bristol Aeroplane Co., Ltd., and who has previously contributed valuable articles to* The Aircraft Engineer, *points out that at the R.A.E. the method is to assume a similar wire broken on the opposite side of the wing structure, thus getting symmetrical loading. This assumption is based on investigations carried out at the R.A.E., but no results have been published, and no mention of the difficulty is made in Air Publication No.* 970. *Mr. Russell has made certain general calculations, and the results are given in the following article.*

An engineering framework is an arrangement of members (struts, ties) suitably connected together by a series of joints, such that no geometrical distortion can take place under any condition of applied loads. It is possible to fulfil this condition with a certain minimum number of members, depending on the number of joints. For a frame lying in one plane, the most simple form is an arrangement of three members, connected by three joints to form a triangle. For every extra joint added, two extra members are required. For such a "plane frame," the minimum number of members necessary is given by $2j-3$, where $j$ is the number of joints. Likewise, the most simple form of "space frame" is the tetrahedron, and for each joint added three more members are required. Thus for a framework in three dimensions, the minimum number of members necessary is given by $3j-6$.

A structure consisting of the minimum number of members required to give geometrical rigidity is said to be "just stiff." In this case, the failure of any one member results in complete collapse when under a system of forces. An apparently correctly designed member might fail due to unforeseen causes, such as chemical action, vibration or damage from outside sources. In order that local damage may not be disastrous, structures are usually made redundant, *i.e.*, extra members are added, so that in the event of damage to certain of the principal members, the loads are balanced by a redistribution of stress.

In normal aeroplane wing structures, redundancy is provided by bracing at the interplane struts, either by a pair of wires or by a single strut (*i.e.*, incidence bracing). This arrangement provides an alternative path for loads normally taken in the lift wires or in the drag bracing. For example, if the front lift wire fails, the lift is taken through the incidence bracing to the rear lift wire. This obviously means a complete redistribution of loads. The compression in the front spar is reduced, and increased in the rear spar; also the loads in the drag bracing are altered, due to the new fore-and-aft component at the interplane strut panel. The failure of a lift wire may not be expected to occur simultaneously on both sides (port and starboard), so that the wing centre-sections are subjected to unsymmetrical forces. If the loads on the undamaged side remain unaltered, the loads in the centre-section bracing are very severe. There is reason to suppose that the conditions on the undamaged side are considerably modified, giving great relief to the apparently highly-stressed members. This relief will be investigated in this article.

The stresses in a redundant structure cannot be found by the methods of simple statics. A very close approximation, however, is given by the now well-known method of "Strain Energy." Briefly the theory involved in these calculations is as follows:—

Calculate the loads in the structure, assuming that the redundant members are slack (*i.e.*, can take no load). Next give each redundant member, in turn, tensions, $T_1$, $T_2$, $T_3$. These tensions will induce loads in all other members, so that the load in any one member may be expressed as

$$P + aT_1 + bT_2 + cT_3 \ldots$$

The work done in stretching this member will be

$$U = \tfrac{1}{2}(P + aT_1 + bT_2 + cT_3 \ldots)\,e$$

where $e$ = extension

$$\therefore U = \tfrac{1}{2}\,(P + aT_1, + bT_2 + cT_3 \ldots)^2 \times \frac{L}{AE}$$

Now the loads in the redundancies adjust themselves so that the total work done on the whole structure is a minimum. The tensions $T_1$, $T_2$, $T_3$ may be calculated by partially differentiating and equating to zero.

$$\text{Thus } \frac{\delta U}{\delta T} = \Sigma \frac{aL}{AE}\,(P + aT_1 + bT_2 + cT_3 \ldots) = 0$$

$$\frac{\delta U}{\delta T} = \Sigma \frac{bL}{AE}\,(P + aT_1 + bT_2 + cT_3 \ldots) = 0$$

$$\frac{\delta U}{\delta T} = \Sigma \frac{cL}{AE}\,(P + aT_1 + bT_2 + cT_3 \ldots) = 0$$

In applying this method to the incidence wire of a wing structure it is necessary to know the lengths and areas of each member in the structure. Since these values vary considerably according to the size and type of aircraft, it is not possible to give a general solution. An indication of the probable effect of incidence wires in unsymmetrical loading may be found by examining a particular case.

For this investigation a biplane of the proportions shown in Fig. 1 will be used.

TABLE I.
*Geometry of Structure.*

| Member | $x$ | $y$ | $z$ | L'ght. | $l$ | $m$ | $n$ |
|---|---|---|---|---|---|---|---|
| Lift Wires — Outer bays | — | 2·75 | 2·0 | 3·40 | — | 0·809 | 0·588 |
| Lift Wires — Inner bays | — | 2·0 | 2·0 | 2·83 | — | 0·707 | 0·707 |
| Incidence wires .. | 1·0 | — | 2·0 | 2·24 | 0·446 | — | 0·892 |
| T.C.P. incid. wires .. | 1·0 | — | 1·0 | 1·41 | 0·707 | — | 0·707 |
| T.C.P. cross wires .. | — | 1·0 | 1·0 | 1·41 | — | 0·707 | 0·707 |
| Drag Wires — Outer bay .. | 1·0 | 2·75 | — | 2·93 | 0·341 | 0·938 | — |
| Drag Wires — Inner bay .. | 1·0 | 2·0 | — | 2·24 | 0·446 | 0·892 | — |

Further assumptions must be made as regards the applied forces on the structure. The simplicity of these assumptions will not affect the validity of the conclusions drawn. Accordingly, the entire lift "L" will be taken on the front truss and distributed such that the

TABLE II.
*Loads in Members.*

| Member | C.P. forward | Front Outer Wire cut | Front Inner Wire cut | Area × 10⁻⁵ |
|---|---|---|---|---|
| Lift Wires — Front outer .. | 0·340 L | — | 0·170 L | 0·30 L |
| Lift Wires — Front inner .. | 0·566 L | 0·142 L | — | 0·50 L |
| Lift Wires — Rear outer .. | — | 0·170 L | — | 0·15 L |
| Lift Wires — Rear inner .. | — | 0·142 L | 0·283 L | 0·25 L |
| Top Front Spar — Outer bay .. | 0·275 L | — | 0·138 L | 1·2 L |
| Top Front Spar — Inner bay .. | 0·675 L | 0·038 L | 0·138 L | 1·2 L |
| Top Front Spar — Centre section .. | 0·675 L | 0·138 L | 0·063 L | 1·2 L |
| Top Rear Spar — Outer bay .. | — | 0·275 L | — | 1·0 L |
| Top Rear Spar — Inner bay .. | — | 0·475 L | 0·400 L | 1·0 L |
| Top Rear Spar — Centre section .. | — | 0·475 L | 0·400 L | 1·0 L |
| Btm. Front Spar — Outer bay .. | — | 0·138 L | — | 1·0 L |
| Btm. Front Spar — Inner bay .. | 0·275 L | 0·238 L | 0·063 L | 1·0 L |
| Btm. Rear Spar — Outer bay .. | — | — | — | 0·8 L |
| Btm. Rear Spar — Inner bay .. | — | 0·275 L | — | 0·8 L |
| Top Wing Drag Wires — Outer bay .. | — | 0·147 L | — | 0·13 L |
| Top Wing Drag Wires — Inner bay .. | — | 0·112 L | 0·224 L | 0·20 L |
| Top Wing Drag Wires — Centre section .. | — | — | — | 0·20 L |
| Btm. Wing Drag Wires — Outer bay .. | — | 0·147 L | — | 0·13 L |
| Btm. Wing Drag Wires — Inner bay .. | — | 0·112 L | 0·224 L | 0·20 L |
| Incid. Wires — Outer struts .. | — | 0·112 L | — | 0·10 L |
| Incid. Wires — Inner struts .. | — | — | 0·224 L | 0·20 L |
| Incid. Wires — c/s struts .. | — | 0·071 L | 0·142 L | 0·13 L |
| Centre Section Cross Wires — Front .. .. | — | — | — | 0·20 L |
| Centre Section Cross Wires — Rear .. .. | — | — | — | 0·20 L |

All struts have been omitted, since the energy stored in them is small compared with that in spars and wires.

The areas of members have been fixed as follow:—

*Wing Spars (Steel).*

Top front spar.—Assume the end load stress in the outer bay to be 10 tons per sq. in.

Then area = $0.275\ L/22{,}400 = 1.2\ L \times 10^{-5}$ approx.

Top rear spar.—Assume 80 per cent. of front = $1.0\ L \times 10^{-5}$ approx.

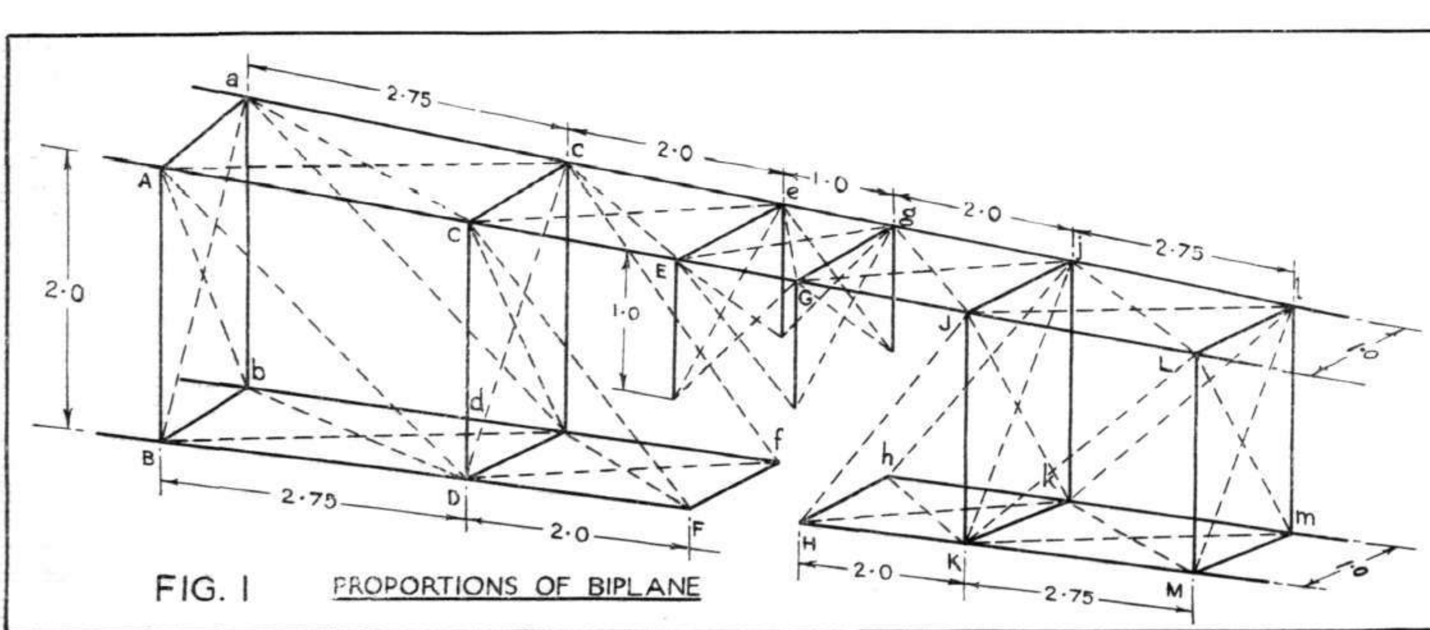



FIG. I PROPORTIONS OF BIPLANE

applied force at joints, A, B, C, D, E and G, J, K, L, M, is 0.1 L.

Before the areas of members can be estimated, the loads, as found by standard methods, must be calculated. Table II gives the loads for three cases corresponding to centre of pressure forward, normal flight, and two cut wire conditions. The required factor for the last two cases is half that of the normal flight case.

Bottom front spar.—Assume 80 per cent. of top front = $1.0\ L \times 10^{-5}$ approx.

Bottom rear spar.—Assume 80 per cent. of bottom front = $0.8\ L \times 10^{-5}$ approx.

For all wires assume that the maximum load in the three cases considered produces a stress of 50 tons per sq. in. Certain of the wires have to be guessed, *e.g.*, the

centre-plane cross-bracing; in this case a similar wire to the maximum drag bracing wire is taken.

Since all members have now been given a length and an area, calculation by "Strain Energy" methods may be commenced.

The first case to be examined will be with a front outer lift wire broken. There will be four redundancies, three incidence wires $c$D, $j$K, L$m$ and the drag bracing wire in the top centre plane, E$g$.

Loads are first calculated ignoring the redundant members. These are tabulated in column 3 of Table III. It can be seen that the transference of lift from the front to the rear truss produces large end loads in the rear spar. On the undamaged side, the lift comes straight through the front truss. These unsymmetrical forces on the centre-section produce loads in the cross-bracing wires considerably higher than those in any of the lift wires. Alternatively, had the cross wires been chosen as the redundancy, there would have been correspondingly large loads in the top centre-plane drag and incidence wires. It is not necessary to design these wires for such loads, for it is recognised that large relief is given by the incidence wires. In normal calculations for "cut wire" cases it is usual to assume pairs of wires broken, *i.e.*, corresponding wires on both port and starboard. This assumption removes all unsymmetrical forces.

In the next step wires $c$D, $j$K, L$m$ and E$g$, are given tensions $T_1$, $T_2$, $T_3$ and $T_4$, respectively. The loads induced in the remainder of the structure are tabulated in columns 4, 5, 6 and 7 of Table III.

Partially differentiating with respect to $T_1$ for the whole table and equating to zero.

TABLE III.

*Front Outer Wire Cut—Calculated Loads.*

| Column. | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Member | | Area × L=ι 10-5 | Lngth | P | $aT_1$ | $b\ T_2$ | $c\ T_3$ | $d\ T_4$ | Final load |
| Wing Spars, Top Front | AC | 1·2 | 2·75 | — | — | — | — | — | — |
| | CE | 1·2 | 2·0 | +0·075 L | −0·892$T_1$ | — | — | — | −0·215 L |
| | EG | 1·2 | 1·0 | −0·675 L | — | −1·784 $T_2$ | +4·236 $T_3$ | — | −0·431 L |
| | GJ | 1·2 | 2·0 | −0·675 L | — | −0·892 $T_2$ | + 3·344$T_3$ | — | −0·415 L |
| | JL | 1·2 | 2·75 | −0·275 L | — | — | +1·226 $T_3$ | — | −0·137 L |
| Wing Spars, Top Rear | a c | 1·0 | 2·75 | −0·550 L | — | — | — | — | −0·550 L |
| | c e | 1·0 | 2·0 | −0·950 L | +1·784 $T_1$ | — | — | — | −0·370 L |
| | e g | 1·0 | 1·0 | −0·950 L | +1·784 $T_1$ | — | — | — | −0·370 L |
| | g j | 1·0 | 2·0 | — | — | +1·784 $T_2$ | −4·236 $T_3$ | — | −0·244 L |
| | j l | 1·0 | 2·75 | — | — | — | −2·452 $T_3$ | — | −0·277 L |
| Wing Spars, Btm. front | B D | 1·0 | 2·75 | −0·275 L | — | — | — | — | −0·275 L |
| | D F | 1·0 | 2·0 | −0·475 L | +0·892 $T_1$ | — | — | — | −0·185 L |
| | H K | 1·0 | 2·0 | +0·275 L | — | +0·892 $T_2$ | −3·344 $T_3$ | — | +0·015 L |
| | K M | 1·0 | 2·75 | — | — | — | −1·226 $T_3$ | — | −0·138 L |
| Wing Spars, Btm. rear | b d | 0·8 | 2·75 | — | — | — | — | — | — |
| | d f | 0·8 | 2·0 | + 0·550 L | — | — | — | — | +0·550 L |
| | h k | 0·8 | 2·0 | — | — | — | +2·452 $T_3$ | — | +0·277 L |
| | k m | 0·8 | 2·75 | — | — | — | — | — | — |
| Lift Wires, Front | A D | 0·30 | 3·40 | — | — | — | — | — | — |
| | C F | 0·50 | 2·83 | +0·283 L | +1·262 $T_1$ | — | — | — | +0·693 L |
| | J H | 0·50 | 2·83 | +0·566 L | — | +1·262 $T_2$ | −1·262 $T_3$ | — | +0·590 L |
| | L K | 0·30 | 3·40 | +0·340 L | — | — | −1·516 $T_3$ | — | +0·169 L |
| Lift Wires, Rear | a d | 0·15 | 3·40 | +0·340 L | — | — | — | — | +0·340 L |
| | e f | 0·25 | 2·83 | +0·283 L | −1·262 $T_1$ | — | — | — | −0·127 L |
| | j h | 0·25 | 2·83 | — | — | −1·262 $T_2$ | +1·262 $T_3$ | — | −0·024 L |
| | l k | 0·15 | 3·40 | — | — | — | +1·516 $T_3$ | — | +0·171 L |
| Incidence wires | A b | 0·10 | 2·24 | +0·224 L | — | — | — | — | +0·224 L |
| | c D | 0·15 | 2·24 | — | +1·0 $T_1$ | — | — | — | +0·325 L |
| | j K | 0·15 | 2·24 | — | — | +1·0 $T_2$ | — | — | +0·132 L |
| | L m | 0·10 | 2·24 | — | — | — | +1·0 $T_3$ | — | +0·113 L |
| Top wing Drag wires | a C | 0·13 | 2·93 | +0·293 L | — | — | — | — | +0·293 L |
| | c E | 0·20 | 2·24 | +0·224 L | −1·00 $T_1$ | — | — | — | −0·101 L |
| | E g | 0·20 | 1·41 | — | — | — | — | +1·0 $T_4$ | +0·069 L |
| | G j | 0·20 | 2·24 | — | — | −1·0 $T_2$ | +1·0 $T_3$ | — | −0·019 L |
| | J l | 0·13 | 2·93 | — | — | — | +1·307 $T_3$ | — | +0·148 |
| Bottom Drag wires | B d | 0·13, | 2·93 | +0·293 L | — | — | — | — | +0·293 L |
| | D f | 0·20 | 2·24 | +0·224 L | −1·00 $T_1$ | — | — | — | −0·101 L |
| | h K | 0·20 | 2·24 | — | — | −1·0 $T_2$ | +1·0 $T_3$ | — | −0·019 L |
| | k M | 0·13 | 2·93 | — | — | — | +1·307 $T_3$ | — | +0·148 L |
| Topcentre Plane wires | e N | 0·13 | 1·41 | +0·142 L | −0·631 $T_1$ | — | — | +1·0 | +0·006 L |
| | g P | 0·13 | 1·41 | — | — | −0·631 $T_2$ | +0·631 $T_3$ | −1·0 | −0·080 L |
| | E P | 0·20 | 1·41 | +1·344 L | −2·521 $T_1$ | +2·521 $T_2$ | −6·000 $T_3$ | −1·0 | +0·111 L |
| | g n | 0·20 | 1·41 | +1·344 L | −2·521 $T_1$ | +2·521 $T_2$ | −6·000 $T_3$ | −1·0 | +0·111 L |

$$- \frac{2\cdot0}{1\cdot2} 0\cdot892 \{0\cdot075\,L - 0\cdot892\,T_1\} + \frac{2\cdot0}{1\cdot2} 1\cdot784 \{ -0\cdot950\,L$$

$$+ 1\cdot784\,T_1 \} + \frac{1\cdot0}{1\cdot2} 1\cdot784 \{ -0\cdot950\,L + 1\cdot784\,T_1 \} + \frac{2\cdot0}{1\cdot0}$$

$$0\cdot892 \{ -0\cdot475\,L + 0\cdot892\,T_1 \} + \frac{2\cdot83}{0\cdot5} 1\cdot262 \{ 0\cdot283\,L +$$

$$1\cdot262\,T_1 \} + \frac{2\cdot83}{0\cdot25} 1\cdot262 \{ 0\cdot283\,L - 1\cdot262\,T_1 \} + \frac{2\cdot24}{0\cdot15} T_1$$

$$- \frac{2\cdot24}{0\cdot20} \{ 0\cdot224\,L - 1\cdot0\,T_1 \} - \frac{2\cdot24}{0\cdot20} \{ 0\cdot224\,L - 1\cdot0\,T_1 \}$$

$$- \frac{1\cdot41}{0\cdot13} 0\cdot631 \{ 0\cdot142\,L - 0\cdot631\,T_1 + 1\cdot0\,T_4 \} - 2 \times \frac{1\cdot41}{0\cdot20}$$

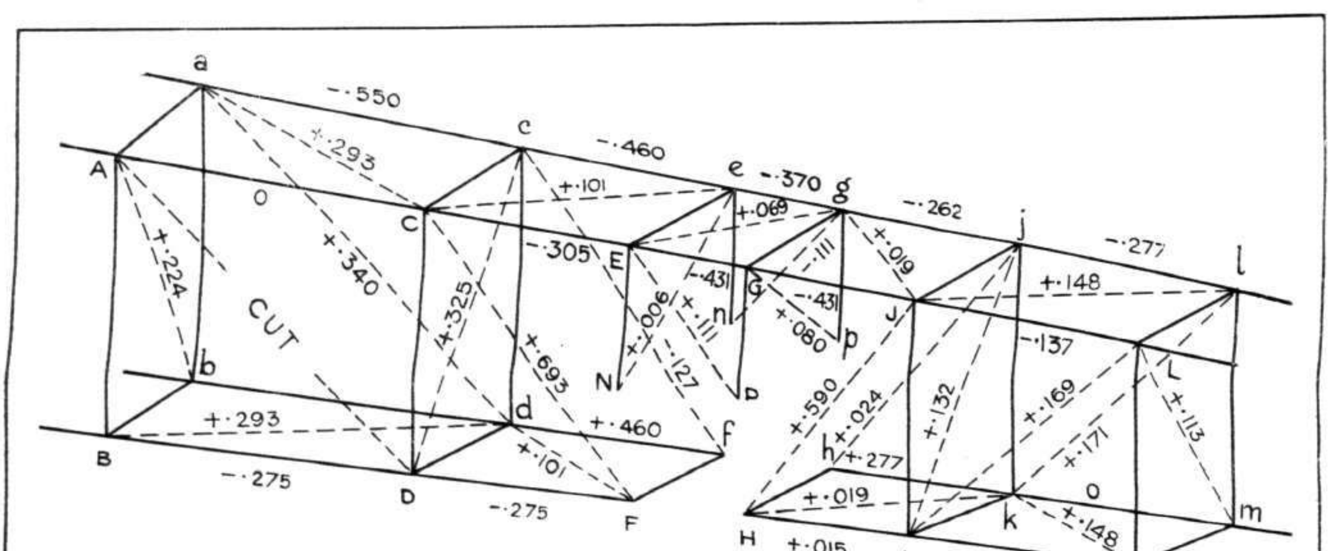



FIG. 2 FRONT OUTER WIRE CUT FINAL LOADS IN MEMBERS

TABLE IV

*Front Inner Wire Cut—Calculated Loads*

| Column | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Member | | Area $\times L^{-1}$ $10^{-5}$ | Lgth | P | $a\,T_1$ | $b\,T_2$ | $c\,T_3$ | $d\,T_4$ | Final Load |
| Wing Spars, Top front | A C | 1·2 | 2·75 | −0·275 L | −1·227 $T_1$ | — | — | — | −0·292 L |
| | C E | 1·2 | 2·0 | −0·275 L | −2·454 $T_1$ | — | — | — | −0·309 L |
| | E G | 1·2 | 1·0 | −0·675 L | — | +1·784 $T_2$ | +4·236 $T_3$ | — | −0·120 L |
| | G J | 1·2 | 2·0 | −0·675 L | — | +0·892 $T_2$ | +3·344 $T_3$ | — | −0·286 L |
| | J L | 1·2 | 2·75 | −0·275 L | — | — | +1·226 $T_3$ | — | −0·163 L |
| Wing Spars, Top rear | a c | 1·0 | 2·75 | — | +2·454 $T_1$ | — | — | — | +0·034 L |
| | c e | 1·0 | 2·0 | −0·800 L | +2·454 $T_1$ | — | — | — | −0·766 L |
| | e g | 1·0 | 1·0 | −0·800 L | +2·454 $T_1$ | — | — | — | −0·766 L |
| | g j | 1·0 | 2·0 | — | — | −1·784 $T_2$ | −4·236 $T_3$ | — | −0·555 L |
| | j l | 1·0 | 2·75 | — | — | — | −2·452 $T_3$ | — | −0·223 L |
| Wing Spars, Btm. front | B D | 1·0 | 2·75 | — | +1·227 $T_1$ | — | — | — | +0·017 L |
| | D F | 1·0 | 2·0 | −0·125 L | +2·454 $T_1$ | — | — | — | −0·091 L |
| | H K | 1·0 | 2·0 | +0·275 L | — | −0·892 $T_2$ | −3·344 $T_3$ | — | −0·114 L |
| | K M | 1·0 | 2·75 | — | — | — | −1·226 $T_3$ | — | −0·112 L |
| Wing Spars, Btm. rear | b d | 0·8 | 2·75 | — | — | — | — | — | — |
| | d f | 0·8 | 2·0 | — | −2·454 $T_1$ | — | — | — | −0·034 L |
| | h k | 0·8 | 2·0 | — | — | — | +2·452 $T_3$ | — | +0·223 L |
| | k m | 0·8 | 2·75 | — | — | — | — | — | — |
| Lift Wires, Front | A D | 0·30 | 3·40 | +0·340 L | +1·517 $T_1$ | — | — | — | +0·361 L |
| | C F | 0·50 | 2·83 | — | — | — | — | — | — |
| | J H | 0·50 | 2·83 | +0·566 L | — | −1·262 $T_2$ | −1·262 $T_3$ | — | +0·331 L |
| | L K | 0·30 | 3·40 | +0·340 L | — | — | −1·516 $T_3$ | — | +0·202 L |
| Lift Wires, Rear | a d | 0·15 | 3·40 | — | −1·517 $T_1$ | — | — | — | −0·021 L |
| | c f | 0·25 | 2·83 | +0·566 L | — | — | — | — | +0·566 L |
| | j h | 0·25 | 2·83 | — | — | +1·262 $T_2$ | +1·262 $T_3$ | — | +0·235 L |
| | l k | 0·15 | 3·40 | — | — | — | +1·516 $T_3$ | — | +0·138 L |
| Incidence Wires | a B | 0·10 | 2·24 | — | +1·0 $T_1$ | — | — | — | +0·014 L |
| | C d | 0·15 | 2·24 | +0·448 L | +1·0 $T_1$ | — | — | — | +0·462 L |
| | j K | 0·15 | 2·24 | — | — | +1·0 $T_2$ | — | — | +0·095 L |
| | L m | 0·10 | 2·24 | — | — | — | +1·0 $T_3$ | — | +0·091 L |
| Top wing Drag wires | a C | 0·13 | 2·93 | — | −1·308 $T_1$ | — | — | — | −0·018 L |
| | c E | 0·20 | 2·24 | +0·448 L | — | — | — | — | +0·448 L |
| | E g | 0·20 | 1·41 | — | — | — | — | +1·0 $T_4$ | +0·056 L |
| | G j | 0·20 | 2·24 | — | — | +1·0 $T_2$ | +1·0 $T_3$ | — | +0·186 L |
| | J l | 0·13 | 2·93 | — | — | — | +1·307 $T_3$ | — | +0·119 L |
| Bottom Drag wires | B d | 0·13 | 2·93 | — | −1·308 $T_1$ | — | — | — | −0·018 L |
| | D f | 0·20 | 2·24 | +0·448 L | — | — | — | — | +0·448 L |
| | h K | 0·20 | 2·24 | — | — | +1·0 $T_2$ | +1·0 $T_3$ | — | +0·186 L |
| | k M | 0·13 | 2·93 | — | — | — | +1·307 $T_3$ | — | +0·119 L |
| Top centre Plane wires | e N | 0·13 | 1·41 | +0·283 L | — | — | — | +1·0 $T_4$ | +0·339 L |
| | g P | 0·13 | 1·41 | — | — | +0·631 $T_2$ | +0·631 $T_3$ | −1·0 $T_4$ | +0·061 L |
| | E P | 0·20 | 1·41 | +1·131 L | −3·471 $T_1$ | −2·523 $T_2$ | −6·000 $T_3$ | −1·0 $T_4$ | −0·240 L |
| | g n | 0·20 | 1·41 | +1·131 L | −3·471 $T_1$ | −2·523 $T_2$ | −6·000 $T_3$ | −1·0 $T_4$ | +0·240 L |

$$2{\cdot}52\ \{\ 1{\cdot}344\,L - 2{\cdot}52\ T_1 + 2{\cdot}52\ T_2 - 6{\cdot}00\ T_3 - 1{\cdot}0\ T_4\}$$
$$1{\cdot}0\,T = 0$$

**Simplifying**

$$-\ 65{\cdot}7\,L + 170{\cdot}5\,T_1 - 89{\cdot}5\,T_2 + 213{\cdot}2\,T_3 - 28{\cdot}7\,T_4 = 0 \quad (A)$$

Similarly by partially differentiating with respect to $T_2$, $T_3$ and $T_4$, and equating to zero

$$+41{\cdot}1\,L - 89{\cdot}5\,T_1 + 170{\cdot}5\,T_2 - 288{\cdot}0\,T_3 - 28{\cdot}7\,T_4 = 0 \quad (B)$$

$$-133{\cdot}8\,L + 213{\cdot}2\,T_1 - 288{\cdot}0\,T_2 + 860{\cdot}0\,T_3 + 77{\cdot}8\,T_4 = 0 \quad (C)$$

$$-17{\cdot}3\,L + 28{\cdot}8\,T_1 - 28{\cdot}8\,T_2 + 77{\cdot}8\,T_3 + 42{\cdot}7\,T_4 = 0 \quad (D)$$

The solution of these four equations gives

$$T_1 = 0{\cdot}325\,L:\ \ T_2 = 0{\cdot}132\,L$$
$$T_3 = 0{\cdot}113\,L:\ \ T_4 = 0{\cdot}069\,L$$

Using these values in columns 4, 5, 6 and 7 of Table III gives the final calculated loads in the members. In order to give a clearer picture of the final conditions, the loads are inserted on the diagram on Fig. 2.

On the side of the "cut wire" it is seen that the lift, transferred from the front to the rear truss by the outer incidence wire gets back to the front truss by the shortest possible route, *i.e.*, the inner incidence wire. Moreover, more lift is transferred by the inner wire than by the outer and this helps to cancel out and reduce the unsymmetrical end loads.

On the undamaged side the outer incidence wire tends to equalise the loads on the two lift trusses, but the inner incidence wire again takes more load back to the front truss.

At the centre section the unsymmetrical loads have so nearly balanced out that the loads in the cross-bracing wires have been reduced by more than ten times; while the loads in the drag and incidence wires are considerably smaller than those in the drag bracing of the outer wings.

In the second investigation, the front inner lift wire is assumed broken. The procedure is as before. The loads are given in Table IV.

Partial differentiation gives the following four equations:—

$$441{\cdot}9\,T_1 + 123{\cdot}5\,T_2 + 293{\cdot}6\,T_3 + 48{\cdot}9\,T_4 = 47{\cdot}4\,L$$
$$123{\cdot}5\,T_1 + 170{\cdot}4\,T_2 + 299{\cdot}6\,T_3 + 28{\cdot}8\,T_4 = 46{\cdot}8\,L$$
$$293{\cdot}6\,T_1 + 299{\cdot}5\,T_2 + 848{\cdot}6\,T_3 + 77{\cdot}8\,T_4 = 114{\cdot}3\,L$$
$$48{\cdot}9\,T_1 + 28{\cdot}8\,T_2 + 77{\cdot}8\,T_3 + 42{\cdot}7\,T_4 = 12{\cdot}9\,L$$

The solution gives

$$T_1 = 0{\cdot}014\,L:\ \ T_2 = 0{\cdot}095\,L$$
$$T_3 = 0{\cdot}091\,L:\ \ T_4 = 0{\cdot}056\,L$$

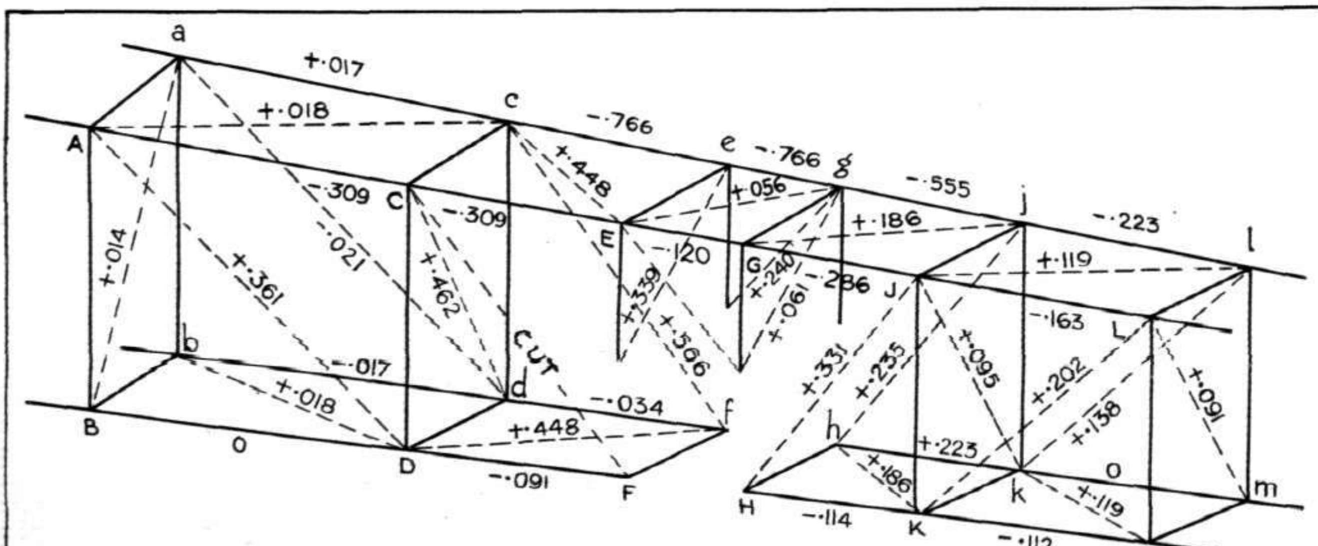



FIG. 3 FRONT INNER WIRE CUT FINAL LOADS IN MEMBERS

The final loads are shown in Fig. 3. It is seen that on the cut wire side, the outer incidence wire takes only a very small load. On the opposite side both incidence wires take approximately equal loads. This case is more severe on the centre section than the previous one, though the loads are still of the same order as those in the main wing drag bracing. The effect of the redundancies is to reduce the load in the cross wires approximately five times.

It can be seen from these two calculations that any attempt to estimate the loads in the centre sections of the wings with a "cut wire," without considering the effect of redundancies, is likely to lead to entirely erroneous results. The effect of a broken wire is felt throughout the structure. The loads in the redundant members adjust themselves in such a manner as to prevent excessive piling up of load in any member so that conditions are not as severe as they seem.

In the case of single-bay aeroplanes, the length of the centre bay affects the proportion of load taken by the drag wire and the incidence wire. A higher load is taken in the drag wire and less in the incidence wire with increase of bay length. This has the effect of increasing the load in the centre-section incidence bracing. Consequently in such cases when cut wire loads are estimated without the use of "Strain Energy," these members should have an ample reserve factor.

It is not practicable to deal with all "wires cut" cases by "Strain Energy" methods as a general procedure, owing to the large amount of work necessary. It is customary to assume a wire cut on each side of the machine, thus removing unsymmetrical conditions. This assumption covers effectively the loads in the outer wings, but possibly underestimates the loads in the centre-section incidence bracing. Also no criterion is given for the cross wires.

It should be remembered that the necessity for "cut wire" calculations is not only to cover the possibility of a wire breaking or being shot away, but also to allow for the effect of the incidence wires on the drag bracing in normal flight. In the standard method of calculation the incidence wires are assumed inoperative, whereas, in fact, they relieve the more heavily loaded truss. By assuming a lift wire to be entirely relieved of load by the incidence wire, and using half the factor as required for the normal case, it is ensured that all bracing is amply strong for the true distribution of load.

## THE MUTUAL INFLUENCE OF ENGINE AND AIRSCREW CHARACTERISTICS

By LT. COL. J. D. BLYTH, O.B.E., A.F.R.Ae.S., M.I.Ae.E.

(*Continued from page* 12)

### ERRATA.

*Two errors crept into last month's instalment of Col. Blyth's article, which readers are asked to correct in their copies.*

*On Fig.* 1 *the figures along the P/D axis should read* ·4, ·6, ·8, *etc., instead of* ·4, ·5, ·6, *etc., thus altering the scale.*

*In equation* (vii) *the fraction* $\frac{Q_c}{T_c}$ *was omitted. The equation should read:*

$$\eta = \frac{1}{2\pi} \cdot \frac{P}{D} \cdot \frac{K_T T_c}{K_Q Q_c} \cdot \frac{V}{nP} \cdot \frac{Q_c}{T_c}$$

If the gear ratio found in this way is not the same as the gear ratio available for the engine in question, there are two courses open, but as neither course will attain the desired result of maximum r.p.m. and maximum efficiency at top speed and normal r.p.m. on climb, some sacrifice of airscrew performance is unavoidable.

The first course is to select a pitch diameter ratio which will give either maximum r.p.m. and maximum efficiency at top speed, or normal r.p.m. on climb together with maximum efficiency at some arbitrary condition. Such an airscrew is of necessity a compromise, and the determining factor upon which the arbitrary selections are made will depend upon the requirements in the way of performance of the machine for which the airscrew is intended.

The second course is to select such a pitch diameter ratio that the ratio $K_{Q_{cl}}/K_{Q_M}$ will give normal r.p.m. on climb and maximum r.p.m. at top speed, basing the selection on the ratio $B.H.P._{cl}/B.H.P._M$ and on the gear ratio available. Since this is not the ideal gear ratio as calculated, it will be found that the value of $K_Q$ at $V/nD_M$ is not $0.01118\ V/nD_M$, which shows that the airscrew will not be developing its maximum efficiency at top speed. Further, the fact that $K_{Q_M}$ is not equal to $0.01118\ V/nD_M$ at the design condition shows that when the airscrew is giving maximum r.p.m. at top speed it is not absorbing the b.h.p. of the engine which was used in calculating the diameter. Consequently the r.p.m. will not be maintained unless the airscrew is modified as described previously.

The term "ideal" as applied to the gear ratio in the preceding paragraph does not mean that such a gear ratio will give the optimum aircraft—or even airscrew—performance; its significance is intended to apply only to the combination of r.p.m. and efficiency at top speed and climb. The advantages to be gained by obtaining the desired combination may be outweighed by other considerations.

Some idea of the variation in gear ratio required may be got by considering the specific cases of three different engines, each at three different values of $V_M$.

Suppose the engine powers and r.p.m. to be as follows:—

| Engine. | A. | B. | C. |
|---|---|---|---|
| Max. r.p.m. ... | 2,420 | 1,950 | 2,700 |
| Normal r.p.m.... | 2,200 | 1,775 | 2,250 |
| Max. b.h.p. ... | 357 | 520 | 575 |
| Normal b.h.p.... | 343 | 460 | 475 |
| Over-revving % | 10 | 10 | 20 |
| Rated altitude... | G.L. | 10,000 ft. | 12,000 ft. |

We will assume the maximum speeds to be 120 m.p.h., 180 m.p.h. and 240 m.p.h. The question as to the possibility of attaining these speeds with the powers available does not arise, as we are looking only into the possibility of maintaining maximum r.p.m. at top speed and normal r.p.m. on climb at the design height, *i.e.*, the rated altitude.

Solving equation (xv) for each speed in the cases of engines A and B, and tabulating results, we get:—

Engine A:

| | | | |
|---|---|---|---|
| V ft./sec. ... ... | 176 | 264 | 352 |
| $n$ = airscrew r.p.s. | 20.7 | 57.2 | 117 |
| Airscrew r.p.m. ... | 1,242 | 3,432 | 7,020 |
| Gear ratio ... ... | 0.508/1 | 1.406/1 | 2.875/1 |

Engine B:

| | | | |
|---|---|---|---|
| V ft./sec. ... ... | 176 | 264 | 352 |
| $n$ ... ... ... | 32.15 | 88.6 | 182 |
| Airscrew r.p.m. ... | 1,929 | 5,316 | 10,920 |
| Gear ratio ... ... | 0.989/1 | 2.725/1 | 5.6/1 |

The gear ratio is the ratio: Airscrew r.p.m./Engine r.p.m.

The airscrew r.p.m. required at high forward speeds are obviously impossible. In the third case of engine B the airscrew diameter becomes 3.83 ft., and the resultant tip speed is over 2,200 ft./sec.

In the case engine C the value of $B.H.P._{cl}/B.H.P._M$ is 0.824. This is greater than the maximum value shown in Fig. 4 for 20 per cent. over-revving, which means that the amount of over-revving is too great for the slope of the power curve; consequently it will be

impossible to design an airscrew to fulfil the required conditions of r.p.m. required both at climb and at top speed.

Assuming that the existing gear ratios are 0.657/1 in the case of engine A, and 1/1 in the case of engine B, and that the airscrews are designed to give maximum efficiency at top speed, we will find at what speeds normal r.p.m. will be maintained.

Engine A.—Gear ratio 0.657/1:

| | | | |
|---|---|---|---|
| $V_M$, ft./sec. ... | 176 | 180 | |
| D, ft. ... ... | 9·88 | 8·93 | |
| $\frac{V}{nD_M}$ ... ... | 0·672 | 1·115 | |
| $K_{Q_M}$ ... ... | 0·00752 | 0·01247 | |
| $\frac{P}{D}$ ... ... | 0·95 | 1·43 | |
| $K_Q$ ... ... | 0·0096 | 0·0159 | At normal r.p.m. |
| $\frac{V}{nD}$ ... ... | 0·4 | 0·925 | At normal r.p.m. |
| V ... ... | 95 ft./sec. | 199 ft./sec. | At normal r.p.m. |
| $0 \cdot 65\ V_M$ ... | 114 ft./sec. | 171 ft./sec. | |

The value of $V/nD$ at normal r.p.m. is obtained from the torque coefficient curve (not shown) which is got by interpolation in Fig. 2.

Engine B.—Gear ratio 1/1:

| | | | | |
|---|---|---|---|---|
| V, ft./sec. ... | 176 | 264 | 352 | |
| D, ft. ... | 10·58 | 9·55 | 8·89 | |
| $\frac{V}{nD_M}$ ... ... | 0·5105 | 0·851 | 1·218 | |
| $K_{Q_M}$ ... | 0·00571 | 0·00952 | 0·01363 | |
| $\frac{P}{D}$ ... ... | 0·75 | 1·15 | 1·53 | |
| $K_Q$ ... ... | 0·00672 | 0·012 | 0·01605 | At normal r.p.m. |
| $\frac{V}{nD}$ ... ... | 0·37 | 0·75 | 1·09 | At normal r.p.m. |
| V, ft./sec. ... | 116 | 212 | 287 | At normal r.p.m. |
| $0 \cdot 65\ V_M$ ... | 114 | 171 | 229 | |

These results show that in the first case with engine A normal r.p.m. are maintained at a speed lower than the best climbing speed, so will exceed normal r.p.m. on climb at full throttle and throttling will be necessary. In the second case normal r.p.m. are reached at a speed greater than climbing speed, consequently the airscrew will hold the r.p.m. down to a lower value on climb, and power will be lost.

With engine B normal r.p.m. are maintained on climb in the first case only, as the maximum speed increases the speed at which normal r.p.m. are maintained becomes more and more in excess of the climbing speed, and the r.p.m. on climb continually decrease.

We will take now the case of engine B, and by assuming various gear ratios examine the effect which gearing has on the speed at which normal r.p.m. are maintained, taking in each case 180 m.p.h. as the maximum speed of the machine, *i.e.*, the speed at which the airscrew is designed for maximum efficiency and maximum r.p.m.

It should be understood that at present we are considering only the question of r.p.m. and speed; the effect on the net or propulsive efficiency of the airscrew will be examined later.

Engine B. Maximum forward speed = 180 m.p.h.
$V = 264$ ft./sec.

| Gear ratio. | 0·5/1 | 1/1 | 1·5/1 | 2/1 | 2·5/1 |
|---|---|---|---|---|---|
| D, ft. ... | 13·51 | 9·55 | 7·79 | 6·75 | 6·04 |
| $\frac{V}{nD_M}$ ... | 1·202 | 0·851 | 0·694 | 0·602 | 0·538 |
| $\frac{P}{D}$ ... | 1·52 | 1·15 | 0·975 | 0·86 | 0·78 |
| $K_{Q_M}$ ... | 0·01345 | 0·00952 | 0·00776 | 0·00672 | 0·00602 |
| $K_{Q_N}$ ... | 0·01584 | 0·0112 | 0·00913 | 0·00791 | 0·00708 |
| $\frac{V}{nD_N}$ ... | 1·075 | 0·74 | 0·57 | 0·465 | 0·395 |
| $nD_N$ ... | 200 | 282·5 | 345 | 400 | 447 |
| $V_N$, ft./sec. | 215 | 209 | 197 | 186 | 176 |
| $V_{cl}$, ft./sec. | 171 | 171 | 171 | 171 | 171 |

The subscript N denotes conditions at normal r.p.m. where these do not occur at $V_{cl}$.

On examination of this table we see that unless the airscrew is geared to rotate at over 2.5 times the engine speed, normal r.p.m. are not attained until the forward speed is greater than the required 171 ft./sec., and that the lower the airscrew r.p.m. the greater the forward speed becomes at which normal r.p.m. are maintained.

From various considerations it would not pay in practice to gear the airscrew to give r.p.m. greater than those of the engine. We will examine first the effect of the airscrew diameter on the additional drag due to the increased resistance of the parts of the machine in the slipstream.

$K_r$ = Parasitic drag coefficient of the whole machine.
$K_s$ = Parasitic drag coefficient of the parts in the slipstream.
$A_w$ = Wing area (to which all coefficients are referred).
V ft./sec. = Forward speed.
$V_s$ ft./sec. = Total speed of slipstream.
A sq. ft. = Cross-sectional area of slipstream.
D ft. = Diameter of airscrew.

Assuming that, owing to the contraction of the slipstream, its cross-sectional area is 0.7 of that of the airscrew disc

$$A = 0 \cdot 7\,\frac{\pi D^2}{4}.$$

Total drag of machine

$$= \rho A_w V^2 K_r - \rho A_w V^2 K_s + \rho A_w V_s^2 K_s.$$

$$= \rho A_w V^2 K_r + \rho A_w V^2 K_s \left(\frac{V_s^2}{V^2} - 1\right).$$

Additional drag due to slipstream

$$= \rho A_w V^2 K_s \left(\frac{V_s^2}{V^2} - 1\right). \quad \ldots\ldots\ldots\ldots \text{(xvi)}$$

If $b$ = outflow factor and T lb. = total thrust, we get

$$V_s = V\,(b + 1)$$

and

$$T = \tfrac{1}{2}\rho A V^2 b(b + 2)$$

$$= \tfrac{1}{2}\rho A V^2 \left\{(b + 1)^2 - 1\right\}$$

$$= \tfrac{1}{2}\rho A V^2 \left\{\left(\frac{V_s}{V}\right)^2 - 1\right\}$$

whence

$$\left(\frac{V_s}{V}\right)^2 - 1 = \frac{T}{\tfrac{1}{2}\rho A V^2}$$

Substituting in (xvi) we get

$$\text{Additional drag due to slipstream} = \frac{\rho A_w V^2 K_s T}{\tfrac{1}{2}\rho A V^2}$$

$$= \frac{2 A_w K_s T}{A}$$

Additional thrust horsepower required

$$= \frac{2 A_w K_s T}{A} \cdot \frac{V}{550}$$

If $H.P._T$ = total thrust horsepower available, and $H.P._s$ = thrust horsepower absorbed by additional drag due to slipstream

$$H.P._T = \frac{TV}{550}$$

and

$$H.P._s = \frac{2 A_w K_s}{A} \cdot \frac{TV}{550}$$

$$= \frac{2A_W K_S}{0 \cdot 7 \times \frac{\pi}{4} D^2} \cdot H.P._T$$

*i.e.*

$$H.P._S = \frac{3 \cdot 64 A_W K_S}{D^2} \cdot H.P._T \quad \ldots\ldots\ldots\ldots \quad \text{(xvii)}$$

Equation (xvii) shows that the additional thrust horsepower required on account of slipstream drag varies directly as the total thrust horsepower given by the airscrew and inversely as the square of the diameter of the airscrew. It is advantageous, therefore, to make the airscrew diameter as large as possible.

For any particular combination of machine and airscrew the quantity $\frac{3.64 A_W K_s}{D^2}$ in equation (xvii) is constant. Call this constant S.

Net thrust horsepower available $= H.P._T - H.P._s$
$= H.P._T (1 - s)$.

But $H.P._T = \eta \times B.H.P.$, where $\eta$ = airscrew efficiency.

Therefore the net thrust horsepower available $= B.H.P. \times \eta(1 - s)$, and $\eta(1 - s)$ is the net or propulsive efficiency of the airscrew.

*(To be continued)*

## TECHNICAL LITERATURE

### PAPERS AT INSTITUTE OF METALS.

A NUMBER of papers were presented at the 24th Annual General Meeting of the Institute of Metals held in London on March 9 and 10. Of these papers we have space to mention two only: "Intercrystalline Corrosion of Duralumin," by Sidery, Lewis and Sutton, and "Magnesium Alloy Protection by Selenium and other Coating Processes," by Bengough.

"Intercrystalline Corrosion of Duralumin." By A. J. Sidery, Assoc.Met.Member, Scientific Officer, Royal Aircraft Establishment, Farnborough; K. G. Lewis, M.Sc., Assistant Lecturer in Metallurgy, The College of Technology, Manchester; and H. Sutton, M.Sc., Member, Senior Scientific Officer and Head of the Metallurgical Department, Royal Aircraft Establishment, Farnborough, was presented on Wednesday, March 9.

Experiments were carried out to determine the influence of overstrain in tension or in compression and of certain modifications of heat-treatment on the tendency of Duralumin to develop intercrystalline corrosion. For the purpose of evolving a reliable test which would permit the relative susceptibility of various samples of Duralumin to this form of corrosion to be estimated in a reasonable space of time, several reagents were investigated. It was found that partial immersion in a N-1 solution of sodium chloride to which 1 per cent. (by weight) of hydrogen chloride had been added was capable of producing intercrystalline corrosion consistently in samples of Duralumin, where a propensity towards this type of corrosion existed. The effect of overstrain was examined by subjecting to this test a number of specimens of heat-treated Duralumin sheet, to which tensile test had been applied to produce various degrees of permanent elongation, and a number of longitudinal strips cut from samples of heat-treated Duralumin tube, which had been compressed to arbitrarily selected stresses above the elastic limit in compression. The results of the experiments indicated that overstrain in tension increased slightly the tendency towards intercrystalline penetration, but no relation was observed between this tendency and the degree of elongation. There appeared, however, to be a critical range of stress in compression, viz., 14.0-16.9 tons/in.$^2$, for the material employed in the experiments. Samples which had been compressed in this range of stress showed the greatest susceptibility. Corrosion tests were made on samples of the sheet and tube which had been heated at various temperatures in the range 470-520 deg. C., quenched in cold or in boiling water and aged at room temperature with a view to ascertain the influence of such modification of heat-treatment and of quenching medium on the susceptibility of the material to intercrystalline attack. It was observed that, in general, the higher the quenching temperature the smaller was the tendency of the material to develop intercrystalline corrosion, but there was, however, an increased tendency towards the pitting form of superficial corrosion under the conditions of test employed. Material quenched in boiling water showed a very much greater propensity towards the intercrystalline form of corrosion than did material quenched in cold water or in cold oil.

"Magnesium Alloy Protection by Selenium and Other Coating Processes." By G. D. Bengough, M.A., D.Sc., Member, and L. Whitby, M.Sc., Member, Chemical Research Laboratory, Department of Scientific and Industrial Research, Teddington, was presented on Thursday, March 10.

A process has been developed for the production of films of selenium on several light magnesium alloys. These films confer considerable resistance to the corrosive action of sea-water spray. The firms are normally produced by immersion for a few minutes in a bath containing selenious acid at laboratory temperature, but may also be produced by running the alloy with porous material dipped in the bath. The film has the property of self-healing to a limited extent, especially when immersed in stagnant sea water. The film is only a few thousandths of a millimetre thick, and its production does not cause any appreciable dimensional change in the alloys treated. The film forms a satisfactory base for certain types of paint, and further work on this property is proceeding.

## SUMMARIES OF AERONAUTICAL RESEARCH COMMITTEE REPORTS

**These Reports are published by His Majesty's Stationery Office, London, and may be purchased directly from H.M. Stationery Office at the following addresses: Adastral House, Kingsway, W.C.2; 120, George Street, Edinburgh; York Street, Manchester; 1, St. Andrew's Crescent, Cardiff; 15, Donegall Square West, Belfast; or through any Bookseller.**

COLLECTED REPORTS ON BRITISH HIGH-SPEED AIRCRAFT FOR THE 1927 SCHNEIDER TROPHY CONTEST. With an introduction by **W. L. Cowley, A.R.C.Sc.** R. & M. No. 1300. (372 pages and numerous diagrams.) January, 1931. **Price 20s. net.**

In this volume a comprehensive account is given of the large amount of work carried out on the British seaplanes designed for the Schneider Trophy Contest of 1927, held at Venice. The subject-matter is divided into four sections under the following headings:—(*a*) Research, (*b*) Specifications, Design and Construction, (*c*) Inspection and Test, (*d*) Operational. It deals with three different types of machines, the S.5 constructed by the Supermarine Aviation Company, the Gloster IV by the Gloster Aircraft Company, and the Crusader by Messrs. Short Bros. The first of these, the winning type, was a monoplane with a water-cooled engine, the second a biplane with a water-cooled engine and the third a monoplane with a radial air-cooled engine.

The research section of the publication describes work carried out, both before and after the Contest. The research prior to the race was for the purpose of developing the craft, and after the race mainly for investigating points of interest that arose subsequent to the construction of the machines. In the main, this research work consisted of wind-tunnel tests carried out at the Royal Aircraft Establishment and the National Physical Laboratory. The results show clearly the superiority for racing purposes of the water-cooled over the air-cooled engined type, although it was also found that the latter could be greatly improved by cowling the engine cylinders.

Remarkable results were obtained in some of these cowling experiments. Considerable interference sometimes occurred on both lift and drag and the results were in many cases sensitive to small differences, such as sealing up the joints between the cowling and the fuselage. In striking contrast it was found that comparatively little interference occurred at minimum drag between the main components of the S.5. The resistance of the complete model of this machine was found to be only 5 per cent. more than the sum of the resistances of the separate components, and the Gloster IV also showed little interference effect on minimum drag. Other features which formed the subject of tests were the projection of rivet heads on the floats and corrugations on the wings due to radiators. In addition, wind tunnel tests were carried out for the purposes of measuring the heat dissipation from the surface of the wing radiators and tests on floats for the machines were made in the N.P.L. Tank. Some of the floats were also tested in the wind tunnel, while full scale research on many of the airscrew problems that arose was carried out at the Marine Aircraft Experimental Establishment at Felixstowe.

The section devoted to specifications, design and construction, deals mainly with the reports of the designers and constructors of the machines and engines. In addition a copy of the specification of the S.5 is given and reports are appended upon the engines used in the Contest.

Section (c) contains certain reports on testing received from the R.A.E. Such tests were only undertaken in cases where new problems presented themselves. Thus the fuselage of the S.5 was an all-metal monocoque of novel design and a proof test was considered desirable. In the case of the "Crusader" it was required to determine the compression strength of two experimental sections of the wooden monocoque fuselage, while for the "Gloster IV" static stability tests were carried out on the floats.

Section (d) of the volume deals with work directly associated with flying or operating the machines. First of all a report is given which is concerned with the operating of the S.5 at high angles of attack. Measurements are included of the incidence and speed of alighting. Another report deals with the question of cornering at high speeds. An extensive analysis was carried out to determine the best methods to employ, and the times taken to round a given corner were calculated for various cases. It was estimated that the best possible mean speed over a course approximating to that chosen for the Contest was about 3 per cent. below the top speed of the aeroplane. The last report in this section describes the test work on the High Speed Flight and also gives an account of the Contest itself.

THEORETICAL INVESTIGATION OF THE TAKE-OFF TIME OF "SINGAPORE II." By W. G. A. Perring, R.N.C. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1412 (Ae. 533). (10 pages and 4 diagrams.) February, 1931. Price 9d. net.

The tank tests on one-sixteenth and one-thirtieth scale models of the "Singapore II" showed that the water resistance varied considerably with change in the attitude of the hull form on the water: the running attitude during taking off may, therefore, have an important influence in the take-off time. The present investigation has been undertaken to determine theoretically the influence of attitude on the take-off time.

The calculated and observed take-off times are in fairly good agreement. The calculations show that it should be possible to reduce the take-off time by approximately 1½ seconds, if the attitude throughout the run is maintained at an angle of minimum resistance. The take-off time could be reduced by a further 2 secs. if, in addition to taking-off at the angle of minimum water resistance, the "Singapore II" can be flown off at its minimum flying speed.

The overload calculations show that it should be possible to take the "Singapore II" off in no wind, at an all-up weight of 32,600 lb.

DRAG AND INTERFERENCE OF A NACELLE WHEN INSTALLED ON THE UPPER SURFACE OF A WING. By W. G. A. Perring, R.N.C., and C. Callen. R. & M. No. 1414. (24 pages and 18 figures.) September, 1930. Price 1s. 3d. net.

The tests were undertaken to investigate the drag and interference of a nacelle when placed on or above the upper surface of a monoplane wing.

Lift and drag have been measured for the following wing and nacelle arrangements:—

(a) Tapered aerofoil, with engine nacelle at various positions above the chord, but clear of the aerofoil upper surface.

(b) Rectangular aerofoil of R.A.F. 34 section with engine nacelle installed directly on the upper surface of the aerofoil.

In both series of tests the influence of the nacelle on the drag has been determined with and without a fuselage in position, and in a few of the tests the effect of the airscrew slipstream on the drag has been measured.

*Conclusions.*—A nacelle at two nacelle diameters above the wing had only a slight lift interference and a drag interference approximately equal to the nacelle drag. The interference increased as the nacelle axis approached the wing, but decreased as the nacelle was moved forward on the wing.

A nacelle immediately on the wing with its axis 0·6 diameter above the chord, caused a serious drag interference and had also a considerable effect on the lift. The interference decreased progressively as the nacelle axis approached the wing, and when the nacelle axis was coincident with the wing chord, the drag interference was negative.

The presence of the fuselage had no important influence on the nacelle interference except at incidences near the stall.

The airscrew slipstream reduced very considerably the interference when the nacelle was 0·6 diameter above the chord, but had practically no effect on the interference when the nacelle was lowered to 0·46 diameter above the chord.

The tests suggest the following general recommendations for design purposes:—

(a) When a nacelle is installed above and clear of the wing, its axis should be at least 1½ nacelle diameters, but preferably 2 diameters, above the wing chord.

(b) In the case of a nacelle mounted immediately on the wing, the nacelle axis should coincide with the wing chord, but if it is desired to mount the nacelle with its axis above the chord, the height above the chord should not exceed about 0·4 nacelle diameter.

THE DETERMINATION OF THE MOMENTS OF INERTIA OF AEROPLANES. By S. B. Gates, M.A. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1415 (Ae. 536). (8 pages and 7 diagrams.) March, 1931. Price 9d. net.

In aeronautical research work an exact knowledge of the moments of inertia of aircraft is only needed in special problems, and it is only in recent years, with the intensification of work on the spin, in which the values of the moments of inertia occupy a central position, that methods of obtaining them with precision have been seriously considered. In the past we have relied upon calculations from a weight schedule, and in its routine form this estimate is rather crude. The precision of the calculation is limited by the refinement of the weight analysis, and if the greatest care is taken the work is laborious and the error involved is difficult to estimate. Values which were considered good enough for stability and general control calculations became suspect when applied to the theory of the spin, in which much depends on the differences of the moments of inertia, and an accuracy of at least 5 per cent. in such is desirable. The alternative of measurement, by observation of the aeroplane's periods when swung as a compound pendulum, was then projected, and work has been proceeding on this problem at the R.A.F. between 1928 and 1930.

A demonstration is given of the importance of the air forces due to acceleration in influencing the period of an aeroplane when swung as a compound pendulum in air. The periods of a Bristol Fighter when swung in air by cable suspension were measured, and an auxiliary experiment was made on a light model in order to determine the virtual moments of inertia. The moments of inertia finally deduced were compared with two estimates of these quantities from weight schedules.

The author's conclusions are as follows:—(a) a moment of inertia determination by swinging is worthless without a subsidiary test of a model. The virtual moments of the Bristol Fighter, expressed as percentages of its moments of inertia are 27 per cent. of A, 9 per cent. of B, and 3 per cent. of C.

(b) The overall accuracy of a swinging test, corrected for virtual moments, is about 5 per cent.

(c) The complication involved in an accurate measurement of moments of inertia is such that reliance must be placed in general on calculation, of which the order of accuracy appears to be about 10 per cent.

THE EFFECT OF CENTRIFUGAL FORCE ON THE CONTROLS IN A SPIN. By S. B. Gates, M.A. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1416 (Ae. 537). (3 pages.) May, 1931. Price 3d. net.

The difficulty of maintaining full rudder to recover from the spin of Aeroplane H* has raised the interesting question as to what effect the centrifugal forces have on the control moments.

It is estimated that in a spin of Aeroplane H the force at the rudder bar necessary to balance the centrifugal moment on the fully-over rudder is 100 lb., one-third of this being due to the tail skid, which is connected to the rudder. The force to balance the aerodynamic moment is estimated to be 50 lb. The pull necessary to balance the elevator centrifugal moment is estimated as 34 lb. with elevators up and 6 lb. with elevators down. It is probable that with elevator up the centrifugal moment is roughly balanced by the aerodynamic moment.

The centrifugal moments for Aeroplane H are at least twice as large as those in an ordinary spin, but the calculations indicate the necessity of seeing that no superfluous weights are attached to the rudder in spinning tests. They also show the desirability of aiming at static balance in rudder design, in order to make it as easy as possible to hold on full rudder for recovery from a spin.

* R. & M. 1184. Experiments on a model of a single-seater fighter in connection with spinning.—Irving and Batson.

R. & M. 1272. Spinning experiments on a single-seater fighter.—Irving, Batson and Gates.

R. & M. 1403. Measured spins on Aeroplane H.—S. B. Gates.

R. & M. 1404. Free flight spinning experiments with single-seater aircraft, H and Bristol Fighter models.—A. V. Stephens.

WIND TUNNEL TESTS ON A MODEL OF THE "WAPITI," INCLUDING THE EFFECT OF THE SLIPSTREAM OF CERTAIN DERIVATIVES. By A. S. Hartshorn, B.Sc., D. M. Hirst, M.A., and G. F. Midwood. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1419 (Ae. 540). (15 pages and 7 diagrams.) March, 1931. Price 1s. net.

The following tests provide data for calculating the appropriate stability derivatives of the Westland Wapiti fitted with the Jupiter VIII geared engine, and include the effect of the slipstream on the tailplane and rudder characteristics.

Measurements were made of lift, drag and pitching moment and the asymmetric moments due to ailerons, rudder and sideslip, at three incidences corresponding roughly to top speed, climb and take off conditions.

The values of the stability derivatives $M_w$, $M_\eta$, $L_v$, $L_\xi$, $N_v$, $N_\xi$, $N_\zeta$ for the aeroplane in gliding flight are given and also the effect of the slipstream on the derivatives $M_u$, $M_w$, $M_q$, $N_v$. An approximate value of the effect of the airscrew is included and the table given shows the relative importance of the various components of each derivative.

A COLLECTION OF WIND TUNNEL DATA ON THE BALANCING OF CONTROLS. By F. B. Bradfield, Math. & Nat. Sci. Triposes. Communicated by the Director of Scientific Research, Air Ministry. R. & M. No. 1420 (Ae. 541). (16 pages and 25 diagrams.) May, 1931. Price 1s. 3d.

The question of balance of control surfaces is becoming of greater importance as the size of aircraft increases. A number of tests have been made at the R.A.E. from time to time which include data on the balancing of controls. Much of this has not been published. It was, therefore, decided to collect what data seemed of general interest into a single report, repeating some previously published results for ease of reference.

The use of servos is closely related to the question of balance, and a section has been added on servo controls.

The most generally applicable method of balancing is by setting back the hinge of the control surface, though other methods such as horn balancing, are also used. The term "set back hinge" balance will be used when the nose of the control surface is approximately symmetrical. The Frise balance is a variation of the set back hinge balance, applicable to ailerons, in which the nose of the control surface is not symmetrical (see Fig. 1) and this type is considered separately. For the purpose of this report, it is often unnecessary to distinguish the particular control surface under discussion, whether aileron, elevator or rudder, and the general terms "control surface," and "control angle" will be used in speaking of the moving surface, whether it is all-moving or used as a flap behind a fixed surface.

The report has been divided into the following section:—

Section I. Frise ailerons.
" II. All-moving control surface; set back hinge.
" III. Control flap behind fixed surface; set back hinge.
" IV. Control flap behind fixed surface; horn balance.
" V. Servo control surfaces.

SIMPLE TILTING MANOMETER FOR RAPID READING. By James Small, B.Sc., Ph.D. R. & M. No. 1430. (4 pages and 2 figures.) October, 1931. Price 6d. net.

A tilting manometer is described which indicates changes in head of the order of 0·0001 inch of water, and is said to be capable of further refinement. It consists in effect of two limbs of a U tube, one held rigidly and the other capable of being moved vertically by means of a micrometer arrangement. The two limbs are connected by means of rubber tubing and on the surface of the water in the fixed limb there is a fixed float operating a small optical lever. Changes of pressure causing a deflection of the beam of light reflected from the mirror of the optical lever are balanced in the usual way by appropriate vertical movements of the free limb until the beam is restored to its initial position.

# *Private Flying and Gliding*

## LONDON AEROPLANE CLUB NEWS

The London Aeroplane Club will be open on Good Friday, Easter Saturday, Sunday and Monday, and closed for staff holidays on Tuesday, Wednesday and Thursday, March 29, 30, 31.

The last informal dance of the series will be held on Easter Saturday, at 8 p.m. It is hoped that everyone who can do so will turn up. For those who prefer quieter pleasures a cinematograph show will be given the next evening, March 27, through the courtesy of Mr. D. T. Bennett. The programme will commence at 7 p.m.

The Club is pleased to welcome Maj. Travers back to his post after his enforced absence. Flying goes on apace, and new members, like the spring flowers, are arriving daily. One of the hardy perennials, Mr. E. E. Stammers, a pilot of considerable renown and experience, has just returned to the Club after a prolonged business visit to the United States. He flew a lot of the well-known American aircraft, and his accounts of his adventures proved very entertaining.

Two distinguished members of the Club, Messrs. C. W. A. Scott and J. Mollison, have been giving passenger flights to their friends on Club aircraft during the past week, and set off together on Saturday afternoon to Lympne, the starting point of their respective attempted record-breaking flights. The Club wishes them both all the best of luck and a rapid journey.

## CINQUE PORTS FLYING CLUB

The Club has again had a busy week, and several new members have joined. The latest pupils are Miss Stenson and Mr. George Fellows. Mr. Turner successfully passed his "A" licence tests during the week, and Mr. Davis will be doing his this week.

Mr. Charles Scott is staying at Lympne prior to his attempt on the England-Australia record, and Mr. Mollison is also here waiting to start for the Cape.

On Sunday an impromptu balloon-bursting competition was held which was a great success. The first prize went to Mr. Charles L'Estrange, a new member who has quite a lot of experience in flying and is likely to take his "B" licence in the near future. Mr. K. K. Brown compiled a sealed handicap for the event which worked out amazingly well. After the competition was over, he went up and showed the spectators how it should be done.

The Club was honoured by a visit from Lady Drogheda on Sunday, who arrived by road in her attractive S.S. car. She stayed for lunch and joined the Club before leaving.

On Easter Sunday there will be another competition, and a rather special gathering. Anyone who cares to visit the Club on this day will be especially welcome.

**TO PROTECT THE HANWORTH GRASS! Col. the Master of Sempill has had his "Puss Moth" fitted out with a tail wheel instead of the standard skid. The wheel fork and bracket were designed and made in the workshops at Hanworth and the tyre is a small Goodyear airwheel. The fitting has been approved by Farnborough Authorities and can be supplied to anyone at a reasonable price.**

## READING AERO CLUB

The Phillips and Powis School of Flying during the last few weeks have had a satisfying number of new pupils starting instruction. Eight new pupils are under instruction for their "A" licence, and about twelve trial lessons have been given during the last few days, which confirms the general feeling that conditions are improving.

Mr. P. Cruttenden, a pupil undergoing instruction for a "B" licence, successfully completed his first long cross-country flight last week-end, when he returned the visit made by members of the Brussels Club recently. We can strongly recommend anyone touring the Continent to pay this Club a visit; all the members seemed extremely air-minded and most enthusiastic.

Two machines have been delivered to private owners during the last week, one a "Gipsy I Moth" to Mr. C. W. Scott, who is connected with the Forestry Department of Burma, and will be shortly flying the machine out there, and the other a "Cirrus II Moth" to Mr. E. C. Wilson, of Netheravon.

The School had the honour of housing the Prince of Wales' "Puss Moth" on Sunday night last, when Flt. Lt. J. Armour was unable to get through to Hendon owing to foggy weather.

The parachute school has been busy again, several pupils have made practice jumps, including Miss James, of Hurstmonceux Place, Sussex, who made a very successful drop, landing well in the centre of the aerodrome.

## IRISH AERO CLUB

During the first two months of this year the three "Moths" of the Irish Aero Club put up a total of 127 hr. flown, and several new pupils were sent solo. The series of lectures by the Club instructors, Messrs. W. R. Elliott and C. F. French, and the ground engineer, Mr. L. J. Stanton, have proved very popular, and have been largely attended by members of the Club and their friends. It is learned, however, that an effort is to be made to change the constitution of the Club at a special general meeting to be held shortly. At the present time only one-third of the number of members of the Council retire annually, but under the new scheme it is proposed that all members shall retire but be eligible for re-election. The estimates of the Free State Public Services were issued recently, but no vote for civil aviation is called for by the Department of Industry and Commerce, but a token vote of £10 is included in the demands for the Department of Defence as "Assistance to Civil Aviation." It will be recalled that although no "grant-in-aid" was included in last year's estimates, £1,000 was granted to the Irish Aero Club subsequently.

## LONDON GLIDING CLUB

The buildings of the London Gliding Club at Dunstable are rapidly assuming the appearance of a small village, and the third hangar was finished during the last week-end. The wind, which was a light breeze blowing straight up the hill, was admirable for training, and the newly-acquired Dickson primary training glider with little air wheels was hard at work all day. This machine was all the more acceptable as the Zögling was undergoing repairs. Messrs. Bowen and Laurie gained their "A" certificates and Mr. Collins his "B." Both the "Hols-der-Teufel" and "Prüfling" were soared repeatedly by all and sundry. Among those who made more extensive flights on the "Professor" were Messrs. Buxton, Culver, Scott-Hall, Smith and Morland. There is still a little room for beginners, and those wishing to join should write to the Secretary, 35, Milk Street, E.C.2.

# The Whitlet Hoverplane

The Whitlet Hoverplane in its new guise as a biplane being flown on the roof of Selfridge's store in Oxford Street. This model answers to its controls much better than the original little monoplane and gives its users a truer idea of flying. (FLIGHT *Photo.*)

ALL attempts to impart the sensations of flying without abandoning terra firma are open to strong objections if the sensations deviate noticeably from the actual, for the pupil thus initiated will find his first flight baffling. He will have to unravel false impressions to receive the true, which will impose upon him a greater handicap than if he had not submitted himself to "ground" impressions.

On Selfridge's roof garden in Oxford Street, a "Whitlet Hoverplane" has been recently installed to initiate the public into the sensations of flying without the risks. On the whole it imparts to the layman a reasonably good impression. It enables him to operate ailerons and rudder controls and experience their effects. He can turn to starboard or port, perform climbing turns, dive, and recover an even keel.

The machine is a small biplane, built by A. V. Roe & Co., Ltd., and powered with a Douglas flat-twin engine. It is pivoted on a tripod which is supported by wheels, and upon these it travels on a small circular track, performing according to the pupil's handling of the controls.

He alone occupies the cockpit, but receives instructions by telephone from an instructor on the deck. He has full throttle control and an air-speed gauge, and, in fact, complete responsibility for the fundamental controls of a cockpit. He experiences the effect of slipstream and the noise and vibration of the real thing.

The controls are operated automatically by compressed air as the movements with the control column are made, and, naturally, they have not the sensitivity of proper controls, so that a pilot who tries the Hoverplane will immediately notice this difference.

But if this difference be allowed for, it may be said that the pupil does receive a very realistic impression of flying an aeroplane, and after a few hours' practice he should certainly find his first real flight more understandable than normally. He ought to be able to appreciate exactly what his pilot is doing to the controls as the machine manœuvres about, and therefore when he is first asked to take control his actions should not be the wild speculations that they usually are.

The Hoverplane Co., Ltd., of Farnham, Surrey, have produced the machine for preliminary training purposes, and not merely as a source of amusement, and its use for this purpose seems feasible.

# AIR SERVICE TRAINING ACTIVITIES

THE thorough and comprehensive training offered by A.S.T. at Hamble has already attracted large numbers of private and commercial pupils. Several of these are now in residence taking a course, which at the end of two years will leave them fully qualified "B" licence pilots proficient in instrument flying, and moreover they will have the added advantage of holding their "A," "C" and "X" ground engineer's licences. They will also have reached the standard necessary for passing the second-class navigator's examination. At least one parent who recently inspected the establishment decided that his son would be far better there than at Oxford or Cambridge.

The increase of students has recently necessitated the opening of a new lecture room, where, amongst other things, the testing and calibration of aircraft instruments is dealt with.

The fleet available at the school has been augmented, and now consists of four "Atlases," one "Siskin," three D.H. 9 J's, two Avro "Tutors" and four "Avians," some of the latter being equipped for night flying ready for those who wish to carry out the night flying test for their "B" licence.

Amongst the recent pupils are Lady Bailey, who has taken her "B" licence and is now studying for the second-class navigator's certificate, and also Miss Winifred Spooner, who is taking a constructor's course and gaining experience in instrument flying.

The number of R.A.F. reserve officers completing their training is large, and it is expected that this side of the school's work will increase. Squash rackets is being played with increasing interest, and the result of one of their recent matches against Flt. Lt. Clarkson's team is as follows:—

Flt. Lt. C. Clarkson lost to Flt. Lt. H. J. Jenkins (A.S.T.).

Mr. A. C. Irwin lost to Flt. Lt. R. P. Pope (A.S.T.).

Mr. Cameron lost to F/O. M. C. Dudding (A.S.T.).

Mr. T. F. Owen beat Mr. A. R. McMillan (A.S.T.).

The school has now its own colours, these being light blue, green and plum colour, which are taken to be as symbolic of the sky, water and earth.

**Napier Cars Again**

SIR HARRY BRITTAIN, K.B.E., C.M.G., presiding at the general meeting of D. Napier & Son, Ltd., at Acton, on March 21, after referring to the important research, experimental and development work being carried out by Napiers on several new types of aero engines, said:—"In accordance with the broader policy adopted by the board, arrangements are in course for the re-entry of the company into the motor-car business. Steps are being taken so that the company may be able to produce a car of first-class performance, reliability and engineering merit." The 6-cyl. Napier was, of course, world famous.

# Airport News

## HESTON AIR PARK

MONDAY, *March 14.*—Six machines (G-ABFP, G-AAYD, G-ABSO, G-ABSB, G-AAVT, and G-AAPT) returned from Baldonnel, with pictures of the Irish Sweepstake draw proceedings. As they arrived at about the same time, we had the unusual sight of pilots waiting their turn to clear Customs. Of the six, one, the "Meteor" (G-ABFP), piloted by Mr. Styran, made a particularly quick run, taking 2 hr. 30 min. to Baldonnel and 2 hr. 40 min. for the return.

Two machines took the Southern route via Fishguard, and, as they had been reported to Holyhead by Baldonnel, caused a certain uneasiness. Holyhead wired Heston for news and broadcast shipping. This gave proof of the necessity of pilots circling control stations when flying overseas.

Mr. Meny cleared Customs and proceeded to Paris in his "Puss Moth" G-AAXO. Mr. Meny is a director of an important French firm, and uses his machine for business purposes.

*Tuesday, March 15.*—The Hon. Mrs. Gurdon (the Hon. Yoskyl Pearson) flew to Towcester to witness her husband riding in a point-to-point.

G-ABFV, piloted by Capt. Cameron, arrived back from Munich, with the son of Mrs. Spencer Cleaver as passenger, who had been competing in the International Ski-ing Competition. Although he did not win, he was first amongst the English competitors. From Frankfurt to Heston G-ABFV made the remarkably good time of 4 hr. 50 min.

*WEDNESDAY, March 16.*—Mr. S. V. Appleby, the young Englishman from the South of France, who only commenced his lessons on the previous Wednesday, made his first solo flight after 5 hr. 30 min. dual instruction.

Three machines went from Heston for the Lincolnshire, G-AAXZ (Mr. Styran), G-ABLB (Mr. Scholes), and G-ABGS (Mr. Wilson), all with passengers.

*THURSDAY, March 17.*—G-ABBC, the "Cutty Sark," called at Heston on the way from Cowes to Blackpool. Capt. Spooner (brother of Miss W. Spooner) piloted his brother to Towcester to ride in a point-to-point race.

*FRIDAY, March 18.*—Personal Flying Service, Ltd., had two machines off to the Grand National—G-ABFO ("Desoutter"), piloted by Mr. Ledlie, and G-AAVT ("Hendy"), by Maj. Clarke. Mr. S. St. Barbe took two passengers in G-ABGS ("Puss Moth") and Mr. Styran two in G-AAXZ ("Puss Moth"). Several private owners also went.

Airwork, Ltd., machine G-ABEO, piloted by Mr. Ferguson, collected films of the Grand National for Gaumont Films. Mr. Leslie Runciman cleared Customs and departed for Paris in his "Puss Moth" G-ABLG.

*SATURDAY, March 19.*—Amongst the private owners who viewed the Oxford and Cambridge boat race from the air were Mrs. Rhodes-Moorhouse and her son William in their Gipsy II "Moth" G-ABOA.

Two machines cleared Customs for Paris—G-AAXM (Mr. Reiss) and G-ABDM (Mr. Macpherson), Mr. Lindsay Everard, M.P., being one of the party.

"Booted and spurred," Mr. S. Davenport piloted his "Puss Moth" G-AAZM to Cheddington to attend a meet of the Draghounds. He did not leave until after lunch, and was back before 5 p.m., and was very enthusiastic about the use of a plane for such a purpose.

The Hon. Leo Russell was flying his "Gipsy Moth" G-AARI, and very proud of "The Sketch" lady painted on the fuselage.

The new "Fox Moth" made its first appearance at Heston, and many favourable comments were heard. This machine will be at Heston from Friday to Sunday, March 25 to 27, and will be available for demonstrations.

*SUNDAY, March 20.*—Although to-morrow is officially the first day of Spring, to-day has undoubtedly been the finest this year, and in the sun really warm. With such a day, flying became a pure joy, and all Club machines were fully booked, while the Brigade of Guards machine was in full use by their flying members.

Among the many visitors to Heston was Capt. H. Balfour, M.P., who refused to be drawn into any discussion regarding Mr. "Bobbie" Perkins' speech in the House regarding the merits or demerits of women pilots.

Early in the day machines departed for the Continent, amongst them being G-ABTV ("Puss Moth"), with Mr. Harbin and friend for Paris; and G-AAVT ("Hendy"), with Maj. Clarke and one passenger for Le Touquet. G-AAVT made the return journey later in the day.

G-ABSU ("Stinson, Jnr."), which has been for some time in the South of France, returned from Paris to-day for some small repairs, and is leaving again for Cannes next Wednesday or Thursday.

Mr. Lindsay Everard, M.P., and party in G-AAXM and G-ABDM cleared Customs on return from Paris.

The selling agencies at Heston report increased activity during the past week. Among their sales Henlys, Ltd., have sold an Avro "Trainer," "Widgeon," and a "Sports Avian," while Mrs. Vereker has obtained a "Puss Moth" from Brian Lewis & Co. It is an open secret that Mrs. Vereker has an entirely new idea for the colour scheme of her new purchase, and we await the repainting with much interest.

### A Flying Film to See

"HELL DIVERS," at the Empire, Leicester Square, is a film which everyone interested in flying should make a point of seeing. It is strong, magnificent, and amazing. Hollywood Directors, however, have not yet brought themselves to make pictures for the European market as opposed to those which sell in their own country. Take this present example, here is one of the finest displays of flying, made with full co-operation of the U.S. Navy—and when we say *full*, it should be realised that there is literally nothing the Director cannot get. He was given free use of U.S.S. *Saratoga during* the Panama battle practice, and special formation flying was done for his benefit—and that flying has been transferred to the screen by some of the most wonderful photography that we have ever seen; yet the whole show comes within measurable distance of being ruined through the inclusion of so-called "love interest." When you go and see it, cut the story out of your mind and concentrate on the flying. You cannot help but give the U.S. Marines full marks for the way they throw their Curtiss F8C-4 "Hell Divers" (450-h.p. "Wasps") down in power dives on to the target or for their formation flying. The deck landing—including the use of arresting gear which the censor has evidently blanked out at the critical moment—is interesting and well illustrates the use of wheel brakes. Wallace Beery surpasses himself as a "tough guy" and Clark Gable adds further to his laurels as an example of modern efficiency. Our own Navy has given its co-operation on several occasions, but the result has always given one the impression that the film people have not made the most of their opportunities; here, however, there is no doubt about their doing so, still, maybe it's easier for Americans—we should like to see Wallace Beery telling off working parties on board H.M.S. *Hood!*—for their Navy is always willing to advertise itself.

### Sir W. Morris's Gift

SIR WILLIAM MORRIS, who is president of the Wingfield Orthopædic Hospital, at Headington, near Oxford, is giving the whole of the £70,000 which it has cost to rebuild the hospital. Sir William originally agreed to contribute £46,000, but the cost has been greater than expected. In view of his benefaction the committee yesterday decided to rename the institution the Wingfield Morris Hospital.

# Airisms from the Four Winds

**Miss Sewell's Lone Flight Concluded**

MISS IRENE SEWELL, who left Gatwick in a "Gipsy Moth" to visit friends at Amman, Transjordania, arrived there from Cairo on March 19.

**Lady Chaytor Continues**

LADY ISABEL CHAYTOR, who left Lympne on March 5 in a "Gipsy Moth" piloted by Mr. R. T. Richards for Australia, and who was held up at Sofia owing to a minor mishap, continued her journey on March 16 when she flew to Constantinople.

**A Finnish Flight to the Cape**

ON March 19 Capt. Bremer, a Finnish airman, left Helsingfors on a flight to Cape Town, via Germany, Italy, and Egypt.

**New York to Cork**

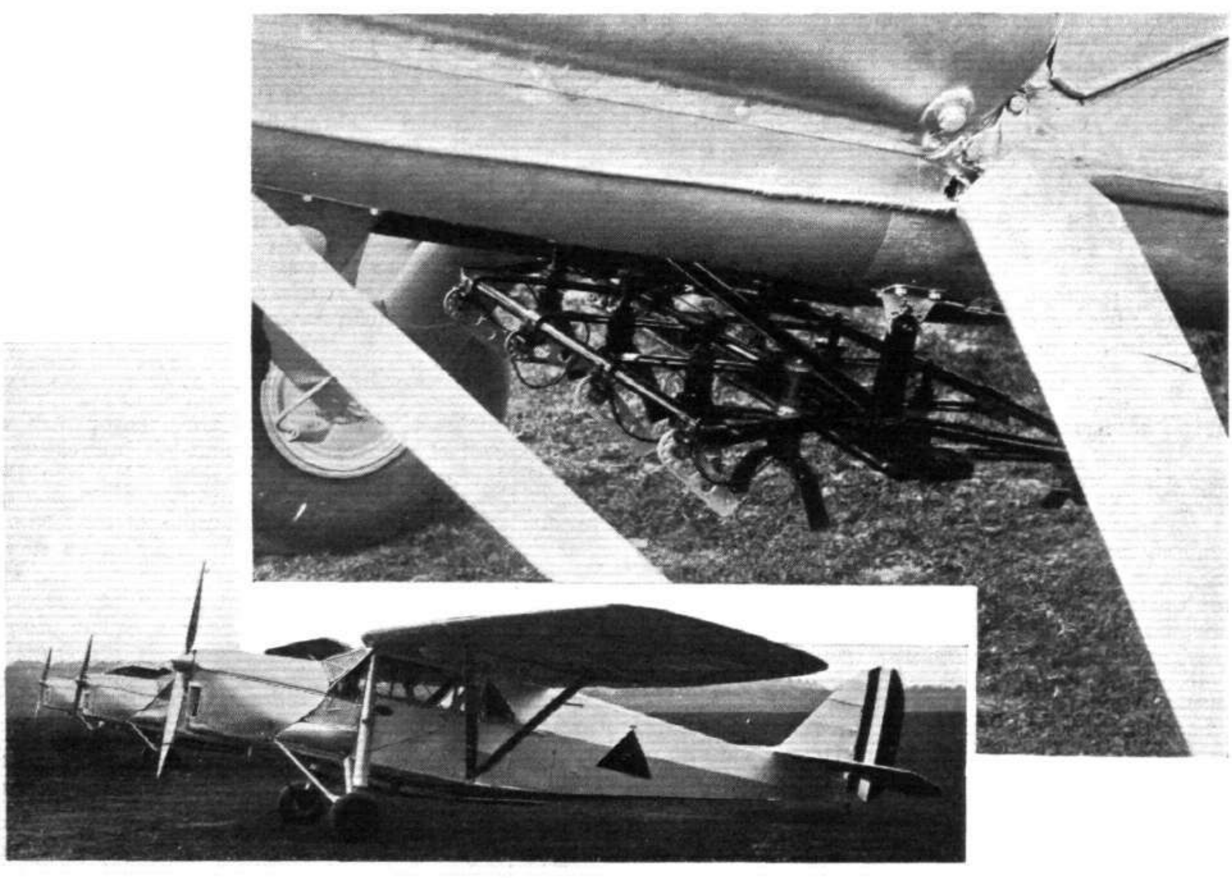
IT is learned in Cork that an English airman, whose name has not yet been divulged, is to attempt a trans-Atlantic flight from New York to Cork during the summer. The flight is in conjunction with the Irish Industrial and Agricultural Fair, which is to be held near Cork from May to September, and the landing is expected to be made on lands adjoining the Fair ground.

**Mr. John Tranum Home**

MR. J. TRANUM, who, together with Mr. Oscar Garden, has been creating so much interest with the Spartan Circus in South Africa, arrived back home on March 21. He tells us that the interest displayed by the larger towns out there was amazing and that he hopes to continue his tour the next winter. In the meantime he is staging a series of displays in this country, starting at Ramsgate this Easter week-end, where from Saturday to Monday he will give a daily display for Aviation Transport Sales & Service, Ltd. Mr. Tranum will, of course, be giving parachute jumps, while Mr. Cummings and others will be giving a series of displays on the "Spartans." Mr. Higgs, for A.T.S. & S., Ltd., has chartered a "Westland Wessex" in order to provide those wishing to joy-ride with a wide selection of aircraft from which to choose. We were interested to hear that, in spite of all he had been told, in South Africa Mr. John Tranum did not have the slightest difficulty in making any of his 54 parachute jumps. A great deal of trouble had been forecast for him owing to the rarified air, but although 14 of his jumps were made at aerodromes whose altitude was over 6,000 feet, he noticed very little difference between these places and the sea level. Except on one occasion, he used the 24-ft. Service Irvin parachute with the Navy-type quick-release throughout.

**Diesel Engines on Airships**

ACCORDING to an announcement by P. W. Litchfield, President of the Goodyear Tyre & Rubber Co., successful tests have been made with one of the Goodyear blimps, fitted with Diesel engines. Two of these engines—we believe of the Packard type—were at hand, and it was thought that these could easily be adapted for use on airships. The *Defender*, the largest of the fleet of six Goodyear non-rigid airships, was selected for the installation, following which a number of tests were carried out. A flight of 150 miles from Akron was the first test, and shortly after the start weather conditions developed to storm proportions. It was reported, however, that the *Defender* behaved splendidly. Capt. Karl Fickes, who was in command, said: "The motors behaved perfectly. While the cruising speed of the ship with petrol motors was around 42 m.p.h., the *Defender*, with its twin Diesels, stepped up to 55 without loss of fuel economy. Since the wind was adverse and we had carried only the amount of fuel appropriate to a comparatively short flight, we had to keep this factor in mind in directing the ship's speed, but we landed back at the Goodyear airship base with almost half of our original fuel untouched. The positive acceleration given by the Diesel type of motor is a source of great satisfaction to the pilot. There is no spitting and spluttering, as in the case of a petrol motor, when it is starting or is suddenly accelerated. You push the throttle forward and the ship drives ahead. It takes off like an aeroplane. Another interesting feature is that, with the absence of electrical ignition, there is no radio interference, as there is apt to be, no matter how perfectly the ignition is shielded, in a petrol-motored ship."



**OFFENSIVE "PUSS MOTHS": The Government of Iraq has ordered from the de Havilland Company a batch of "Puss Moths" fitted with bomb racks. Another version of this machine is fitted up as an aerial ambulance.** (FLIGHT *Photos.*)

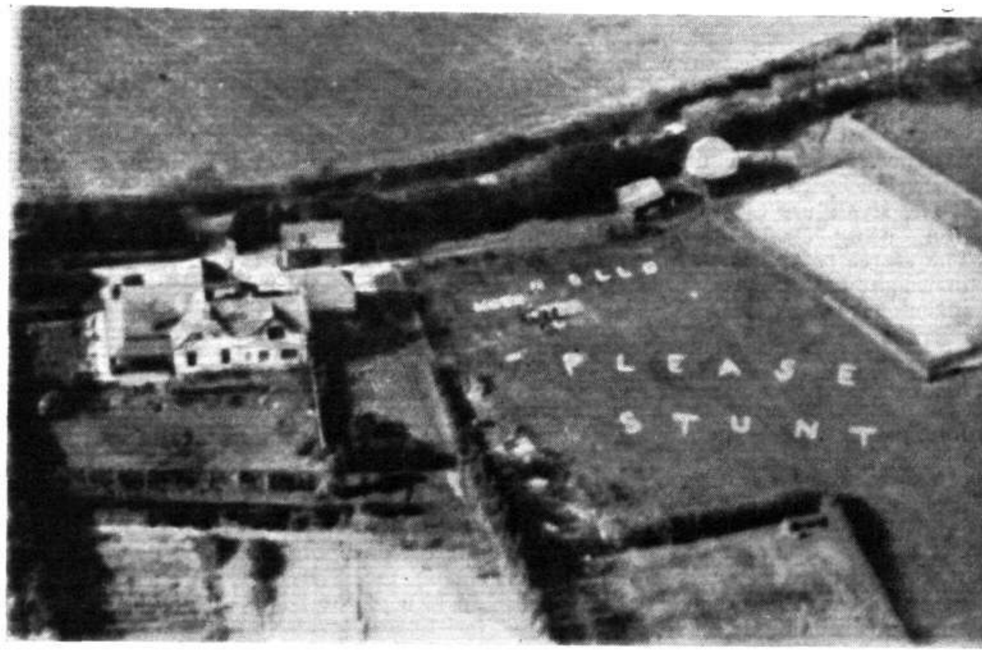
# *Correspondence*

***The Editor does not hold himself responsible for opinions expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters intended for insertion in these columns.***

## " PLEASE STUNT "

[2793] If it is not encroaching too much on your valuable space in your esteemed paper, we would like to refer as briefly as possible to a paragraph which appeared under "Heston Air Park" news of FLIGHT for March 11 last.

It mentioned that a pilot, on landing at Hamble, said he had seen a panel on a lawn, reading "Please Stunt"; and, having complied with the request, was told when recounting his experiences, that the chap next door reports all low-flying aeroplanes to the Air Ministry. This is quite untrue; actually he reported two or three in the spring of two years ago. Since that time many pilots have been kind enough to perform as requested, and no numbers have been reported.



**" Please Stunt ! "**

Surely the fact that the ground panel is still displayed is sufficient proof that we are quite satisfied, ourselves, that no more trouble will come from this source. The last thing we want to do is to get pilots into trouble for low flying. In our ground strips there is no reference that we wish people to low-fly. On the contrary, nothing gives us more pleasure than a clean, well carried out aerobatic display at a reasonable height. The word "Stunt" may be rather misleading, but it is only through lack of space and ground strips that it does not read "Aerobatics, please."

We hope the pilot (mentioned in connection with this correspondence) has not been altogether deterred by any misleading things he may have heard; and that he will again honour "Please Stunt" with a show next time he is passing.

"THE AEROMANIACS."

Titchfield, Hants.
March 14, 1932.

# THE COLLEGE OF AERONAUTICAL ENGINEERING

DEVELOPMENT at the College of Aeronautical Engineering, Sydney Street, Chelsea, S.W., is proceeding apace. The aeronautical side of this college has only been opened quite recently, yet the number of pupils applying for training already far exceeds the number which can effectively be dealt with. For this reason several of the shops and lecture rooms are being expanded.

During a recent visit we saw the aircraft-engine overhaul shop which has now been made about twice its former size. Music Hall comedians have for some time been wondering over the ultimate destination of flies during the winter months, and we ourselves, in a similar manner, have often speculated as to the resting place of aircraft engines after their useful life was over. Now we know, and Mr. Roberts, the Principal of the College, has shown himself an inveterate bargain hunter in the matter. Here, in his shops, may be seen specimens of every conceivable type of engine. The amazing part of it is, however, that all these engines which are pulled to pieces by the students, refitted and re-assembled, are without exception all run on the school test bed afterwards. On the aircraft constructional side great advance is being made. Here the students are building a complete wooden Westland "Wapiti" to $\frac{1}{3}$ scale, after having made sections of the wings and fuselage to full scale. This little aircraft, when finished, should be a testimony to their skill. We understand also that plans are under way for them to manufacture a full-sized two-seater with an engine of somewhere about **40** h.p. so that by the time they go to Brooklands for the aerodrome part of their training they should be thoroughly conversant with aircraft methods.

Wireless is yet another feature of the curriculum, and in conjunction with the Marconi Company a room has been fitted out for lectures on this subject. Here a qualified man from Marconi's will instruct the budding ground engineer on the care and maintenance of the Marconi sets in most general use.

There is little doubt that this school is filling a decided want, and the pupils when turned out as finished ground engineers after their training here and at Brooklands should have a decided value to all aircraft instructors and operators, at any rate their worth will be known instead of being a matter of speculation

### A " Bystander " Flying Number

THE fifth annual flying number of the *Bystander* will appear on April 20. This is one of the few illustrated society weekly papers which has maintained a constant policy of devoting a page to aviation together with an annual number every year. This time the special features of this enlarged number will, it is hoped, include articles on the Auxiliary Air Force, Air Travel and Private Flying. There will be a double centre page in colour showing scenes on one of the Imperial routes, and altogether, as far as we can see, this number should be an exceptionally interesting one.

# The Industry

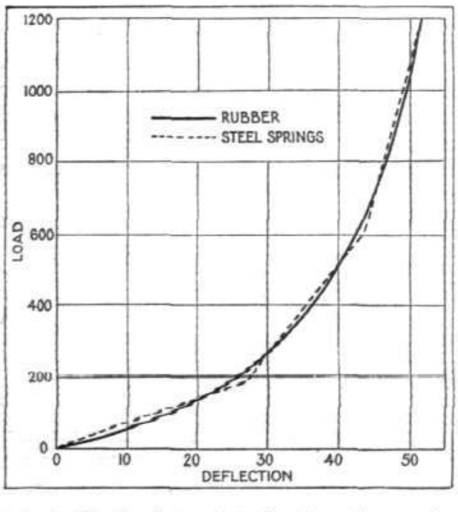
## A NEW ALL-METAL SHOCK ABSORBER STRUT

THE case must be almost unknown where aircraft constructors have obtained an improvement in design which halves both the weight and frontal area of a component. This is, nevertheless, true of the Shock Absorber Strut which has been developed during the last few years by Mr. G. H. Dowty.

The struts are of all-metal construction, using steel spring suspension. The secret of the important reduction in weight and frontal area lies in two ingenious arrangements of the springing elements. In the first case the whole of the strut length is utilised for housing the springs, every inch of space is effectively employed by coupling, in parallel, two or three spring units placed vertically one above the other so that the sprung load is divided equally between the spring units. It will be seen that the greater the number of spring units employed the smaller will be the strut diameter. The number of units that can be used is, of course, limited by the pin centre length of strut and the spring travel required, but in no instance has it been found that the strut width exceeds one half that of other struts having a similar shock-absorbing capacity. It will be appreciated that the small diameter and the use of small fittings is largely responsible for weight reduction.

In early shock-absorber struts, where steel springs were used, considerable loss in weight resulted from several reasons. The use of a single spring was not economical because of the large coil diameter and the low maximum stress which can be developed in a large diameter wire. This latter feature resulted in a heavy spring, but the weight was also seriously influenced by the employment of a spring which, compared with compression rubber or pneumatic suspension, was too powerful.

It is well known that the load deflection diagram of a steel spring is a straight line, whereas rubber or pneumatic systems show a gradual building up of load, with a high deflection rate at the commencement of compression and a low rate at the end. It is evident, therefore, that a single steel spring does not compare favourably with rubber or pneumatic springs. The use of two or more springs, operating in series, one having a high deflection rate and the other a low deflection rate would be practically ideal and result in considerable weight saving. By carefully selecting the coil and wire diameter it is possible accurately to reproduce the load deflection curve of compression rubbers or any other springing medium.




**Comparison of Load-Deflection Curve for Compression Rubber and Three Steel Spring of Varying Capacities, Coupled in Series.**

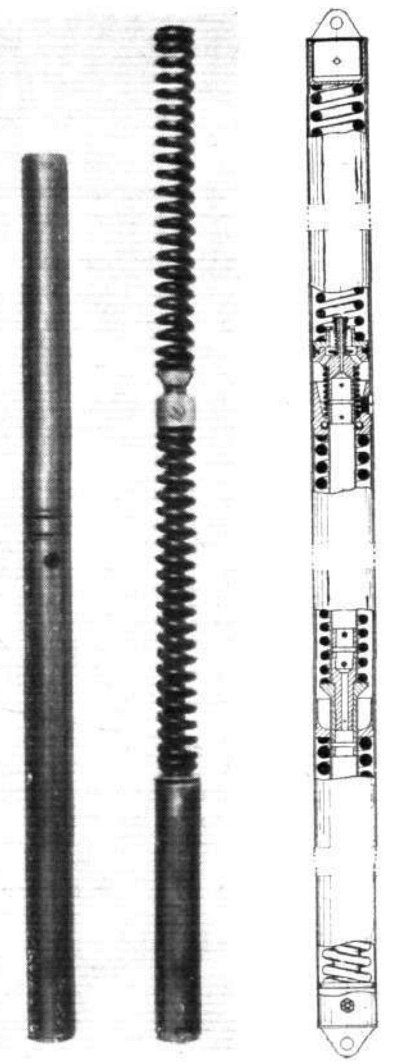
The springing in these struts consists of two separate arrangements. Two or more spring units are coupled together so that they operate in parallel and each of these units consists of two or more springs, of varying capacities operating in series. The struts are manufactured with or without oil dashpots, but in all cases the spring recoil is checked. To obtain an idea of the advantages, the characteristics of several struts at present in use are tabulated below, and comparison with other types go to show that the claims advanced are justified.

| Static Load on Strut. (lb.) | Pin Centre Length. (in.) | Maximum Dia. (in. | Strut Travel. (in.) | Weight (lb.) |
|---|---|---|---|---|
| 800 | 27 | 1·625 | 6·0 | 6 |
| 1,700 | 65 | 1·875 | 6·0 | 13 |
| 2,000 | 42 | 1·875 | 6·5 | 13 |
| 3,700 | 56 | 2·25 | 7·0 | 23 |

The photograph shows an illustration of a strut for 2,000 lb. static load and the section diagram the layout of a strut employing three spring units, each unit consisting of two springs of different capacities operating in series. The effect of this latter refinement is given on the graph. In this instance three springs have been used and the close approximation to a rubber load deflection diagram will be noticed.

Although these struts have only recently been placed on the market, seven aircraft manufacturers have standardised them, and arrangements for manufacture in several foreign countries have been made.

Further particulars can be obtained from the manufacturers and sole licensees, The Aircraft Components Company, Grosvenor Place South, Cheltenham (Telephone: Cheltenham 3755).



**The "Dowty" Strut in section and elevation.**

## AUXILIARY ENGINES

ALMOST all aerodrome authorities, aircraft manufacturers and those connected with the aircraft-engine industry have occasion to use auxiliary engines for providing them with electric light or power. To these people the question must immediately arise whether it is better for them to utilise two-stroke or four-stroke engines. Petters, Ltd., of Yeovil, have for many years specialised on the two-stroke cycle type of engine, either as a paraffin engine or as a semi-Diesel and latterly also for their high speed atomic Diesel type. There is no doubt that the two-stroke heavy oil engine has many advantages. First of all there is the question of regularity, which is influenced by the fact that the four-stroke cycle engine has three out of four strokes negative, or, as it might be termed, unproductive, while the two-stroke has only every other stroke unproductive, since it requires only one revolution of the flywheel for a complete cycle of operations to take place. Another great advantage in the two-stroke type is the absence of valves and valve gear. It has always been admitted that the exhaust valve is the weakest link in the chain as regards a four-stroke engine, and this, in the case of high-speed engines, has invariably been a matter of the greatest concern to designers. The two-stroke cycle, therefore, enables the designer to produce an extremely simple engine, particularly when compared with the four-stroke cycle type, and the experience of Petters, Ltd., has been that since abandoning the four-stroke cycle, the demand for spare parts has fallen to negligible proportions. Yet another matter of importance for engines used for this type of work is its ultimate life, and here the two-stroke type scores very considerably. It has often been said that the scavenge of the cylinders in the two-stroke engine is not as perfect

as that of a four-stroke. It is true that the volume of air admitted to the cylinder for each impulse stroke of a two-stroke engine is less than that of a four-stroke engine, and in consequence the two-stroke engine works at a lower mean effective pressure. The advantage of this lies in the fact that the pressure on the bearings is reduced to about half of those on a four-stroke engine, and the life of the whole engine is thereby greatly increased. That Petters' engines have an amazing length of life we ourselves have recently proved, for not long ago we had, perforce, to stay the night at a small village inn in the middle of Kent. On expressing surprise that electric light was fitted in such an out-of-the-way spot, we were taken to an outhouse and were shown a very aged, small single-cylinder Petter engine. Our host told us that he had rescued this from somebody's scrap heap for a few shillings in 1922, and that the engine had been running steadily ever since. Another which has come to our notice is an aged engine which was rescued from a burnt-out factory. In this case, after the bearings had been seen to and a new magneto fitted, it started without difficulty and has continued to give many years of service.

Petters have recently issued an interesting little booklet on the subject, and this will be sent to our readers who are interested in power matters, on application to the firm at Yeovil, mentioning FLIGHT.

## LUBRICATED LATHE-CENTRES

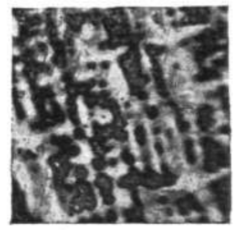
ALL aircraft manufacturers employ grinding machines and use precision parts made on lathes. In most grinding machines it is often found that carbon-steel centres deteriorate very rapidly owing to the abrasive, while for lathe work where great accuracy is entailed, an accurate centre is of the greatest importance. For both these purposes "Matchless" High-Speed self-lubricating lathe centres are undoubtedly of the greatest value. Made by B. Elliott & Co., Ltd., St. Pancras Works, York Road, London, N.7, they comprise a centre made of high-grade carbon steel, hardened and ground to precision limits which is drilled to enable the fitting of a high-speed steel point. Furthermore, both the point and the centre are drilled to allow grease under pressure to pass through, thereby lubricating the material being machined.

## "CASTROL" AT CROYDON

USERS of "Castrol" brand lubricating oils for aircraft engines should note that in future supplies may be obtained from the Cirrus-Hermes Engineering Co., Ltd., whose works at Croydon are in the westernmost hangar on the north side of the aerodrome.

## ALLOY CASTINGS

NON-FERROUS alloy castings are used extensively by aircraft-engine manufacturers. Yorkshire Engineering Supplies, Ltd., of Wortley, Leeds, specialise in such castings and have done for many



**Sand Cast Phosphor Bronze.**

years past. Castings, such as for bushes and gear wheels, etc., for the aircraft industry are all made by the special "Eatonia" water-cooled process, a process which gives the closest possible grain to all non-ferrous alloys with a consequent increase in durability together with a minimum friction

**"Eatonia" Cast Phosphor Bronze.**

under working conditions. These castings are supplied to all the leading aircraft-engine manufacturers in the country either in the rough form ready for machining or as finished parts, which, of course, are produced in accordance with the requirements of the Aeronautical Inspection Directorate.

# NATIONAL FLYING SERVICES, LTD.

THE Second Annual Ordinary General Meeting of National Flying Services, Ltd., was held at the Hanworth Club on March 16. The Chairman of the company, Mr. J. G. Peel, J.P., was in the chair.

In moving the adoption of the report, the Chairman said that a reconstitution of the board took place in October, 1930.

An examination of the company's activities and the agreements which had been made by the old board had shown that the utmost economy would have to be exercised, and considerable progress had already been made in this direction. It had been found essential that a complete day-to-day control should be given to the administrative details, and the Master of Sempill had undertaken this. He had worked day in and day out, and the future success of the company would be principally due to him. He also wished to pay a tribute to the Vice-Chairman, Mr. Anson, who had taken an immense amount of work off his (the Chairman's) shoulders, and to the other directors for their unfailing and continuous efforts on the company's behalf. Turning to the accounts, Mr. Peel said that the year's working showed a loss of about £68,000. There were several items on the balance-sheet, such as compensations for cancellations of contracts, which represented non-recurring expenditure amounting to some £20,000. Recurring items showed savings of some £18,000, and it had been possible to introduce other economies since the close of the period under review. He then asked the Master of Sempill to say a few words on the position from an operational point of view.

The Master of Sempill said that the firm controlled seven air parks, six of them municipal air parks, and at these over 40 aircraft were in use. In addition they had some 50 private aircraft to maintain. The personnel comprised 10 pilots, 39 technical and 60 non-technical staff. In spite of resignations, the membership numbers had shown no falling-off. Although there was a decrease of about 25 per cent. in total flying hours, air taxis were being better patronised by business people, and the air-taxi mileage showed an appreciable increase. At the end of the period under review 247 members had passed out for "A" licences; 114 new licences were issued during the period, and 107 of them had been renewed. He wished to express his gratitude to the other light aeroplane clubs for their support of the company.

Mr. Anson, in seconding the motion that the report be adopted, said that it was his opinion that, but for the efforts of the Master of Sempill, the company must have gone under.

The motion for the adoption of the report was then put to the meeting and carried.

Mr. Anson was re-elected a director, and, proposing the re-election of Mr. Peel, said that without his financial aid it would have been impossible for them to have carried on. Mr. Jackson, seconding, said that he supposed the Chairman had more money in the company than all the rest of the shareholders put together, and he thought it a matter for congratulation that Mr. Peel should stick to them as he had. Mr. Peel was re-elected.

Mr. Carpmael moved the re-appointment of the auditors, and Mr. Ouzman, seconding, pointed out that the value of the freehold property held by the company had increased enormously since they had bought it. The proceedings then terminated.

# THE DEVELOPMENT OF NAVAL AIR WORK

CAPT. N. F. LAURENCE, D.S.O., A.D.C., R.N., read a most interesting and instructive paper on "The Development of Naval Air Work" before the Royal United Service Institution on Wednesday, March 16. Vice-Admiral B. E. Domville, C.B., C.M.G., was in the chair, and, in introducing the lecturer, informed the audience that, though he had once been best known to his brother officers as a submarine commander, he had since been in command of an aircraft carrier.

Capt. Laurence said that he had first asked to be excused from reading this paper, as there was so much which was secret and which he could not mention. He had consented finally, but his paper should rather be called "Random Thoughts on Naval Air Work." He apologised to any officers of the R.A.F. who might be present, saying that he was ignorant of aircraft design and technicalities, and might use wrong terms. He was, however, an air enthusiast, but he would try to give a fair picture. He would confine his remarks entirely to aircraft which were carried in ships and worked with the fleet. He said that they had all met the super-air-enthusiast who wanted to abolish the Navy and the Army, and thought that an enemy could be beaten to his knees by aerial bombing of his capital and vital points. He was not one of those. He said that men in the Navy were apt to take extreme views. He remembered that, when submarines were first produced, there were people who said that the gun was dead. In earlier days, when steam first came to the Navy, there was a saying that steam had bridged the Channel. It had not. In time all inventions fell into their proper place, and so he believed that the Fleet Air Arm would in time fall into its proper place.

Practically all the improvements in naval air work had taken place in the last 10 years. Before that the influence of aircraft on naval work was negligible. Now an Admiral who found himself without aircraft would feel severely handicapped. Why did the Navy once neglect this valuable thing? He thought that it was due to the experience the Navy had had of aircraft during the war. They had started with small seaplane carriers. He recounted the results of a number of efforts made by seaplanes during the war, starting with the Cuxhaven raid on Christmas Day, 1914, when nine seaplanes were lowered off carriers, of which seven succeeded in getting off the water, and of these three returned to the carrier under their own power. None of the machines found the airship sheds which were the objective of the raid. After other failures, it became apparent that seaplanes needed a quite smooth sea. Naval officers lost faith in them.

Capt. Laurence said that there were two forms of reconnaissance needed, strategical and tactical. Aircraft were not called on for strategical reconnaissance during the war, as the Navy had other means of getting information. They might have been useful for tactical reconnaissance, but the carriers had to stop to lower the seaplanes over the side and again to pick them up. They were not very efficient. Moreover, the Army needed aircraft more than the Fleet did at that time. A new era commenced when the *Campania* was fitted with a flying deck, and ship-planes were used instead of seaplanes. It was unfortunate that the *Campania*, through a mistake in passing signals, was not present at Jutland. The *Engadine* was in the battle, and sent up a seaplane. This was the first instance of an aircraft report being made during a naval battle. In 1917 the *Furious* was fitted with a landing deck, and later came the *Argus*. So that really they had only peace-time experience to guide them. Undoubtedly the machines, the wireless equipment, and the skill of the observers had all increased very greatly since the war.

Naval aircraft could be employed in two ways, for reconnaissance and for offensive action. An Admiral, on leaving harbour, would probably order an anti-submarine patrol. Aircraft were better for that than were surface ships. When aircraft were up, a submarine had to dive at once. Occasionally, though not normally, the observer could see a submarine after it had dived. Aircraft reports were needed also when rounding a headland, passing through a strait, or passing a hostile port. Next, the aircraft would look out for hostile ships. In that connection Capt. Laurence emphasised that it was most important that the observer should be a naval officer. He said that every sailor knew what mistakes were possible when ships were sighted. Even experienced naval observers had made great mistakes, and the chances of a mistake were greatly multiplied if the observer were not a naval officer. On spotting hostile ships, the aircraft would next try to locate the hostile battle fleet. If that were found, the observers would try to deduce its direction of employment.

Capt. Laurence asserted that the range of vision of an aircraft was not much greater than that of a cruiser, namely, 10 to 12 miles. But the aircraft could fly over what was seen and so send in a fuller report.

When the battleships approached each other, the aircraft spotters became very useful, but they were very vulnerable. The aim of a fleet was always to outrange the other fleet. The limit used to be when the ships could not spot the fall of the shells. Aircraft had now extended that limit. If the enemy were obscured by mist, he could still be hit by ships which he could not see.

Turning to the offensive use of aircraft, Capt. Laurence said that when the enemy fleet was first spotted, the Admiral had to decide whether it was willing to fight. If it were 60 miles away, it could escape, as the speed of fleets was now approximately equal. The only hope was to reduce the enemy's speed. The Admiral could use his torpedo-planes and bombers to try to cripple some of the enemy's ships, and so reduce his speed. If the enemy were willing to fight, the bombers and torpedo-planes could be held back until the gun duel began. A pilot friend of his had suggested a combined attack by flotillas from one side and torpedo-planes from another, while fighters attacked the bridges and controls of the enemy ships. This sounded ideal, but it would be very hard to synchronise all three.

So far he had omitted mention of weather and of hostile aircraft and anti-aircraft action. Being fired at did unsettle a pilot. In peace time, bombers got a very high percentage of hits; so did submarines, but they were not under fire. In thick mist aircraft could do nothing. If the carrier pitched or rolled beyond a certain degree, the aircraft could not get off, or on. It was only fair to add that bad weather affected the surface ships, too. Then the enemy would attack the carriers with his aircraft or with his battle cruisers. If the flying deck were cut up with bombs, the aircraft would be unable to get off. Fighters would be used for protection, but it was no use trying to intercept the enemy aircraft. The fighters might find them over the enemy carrier as they took off, or when they had got over the fleet to which these fighters belonged. Then the question of air supremacy would arise, which was outside the scope of his paper.

Capt. Laurence said that he regarded a carrier as a man o'war with long-range guns and torpedos. Certainly she could not lie in the line of battle, and she needed protection—but so did battleships. Capt. Laurence then gave some conclusions of his own. Air reconnaissance must be most important. Aircraft might perhaps solve the problem of compelling the enemy to fight. For finding the enemy, it was most effective, if the weather was fine. For destroying the enemy when battle joined, he believed that the gun was the only weapon. The mine, the torpedo, and the bomb might meet with some success, but only the gun could bring the weight of metal and rate of fire which would destroy an enemy fleet. He could not imagine aircraft taking the place of ships, but they were an extraordinarily valuable addition to the resources of a fleet.

**New Irish Joy-Riding Company**

IRISH AIR LINES, with headquarters at Waterford, commenced operations as a joy-riding "circus" at Arklow, County Wicklow, last week, and had a very good send off. Equipped with Avro 504 K aircraft they are to tour the country giving joy-rides, and demonstrations of crazy flying and wing-walking. Already arrangements have been completed for visits to thirty-six towns in Ireland, and a director of the company told our Dublin representative that negotiations for other sites are in progress. The touring party, consisting of four pilots and two ground engineers, will be entirely independent of hotels, as all their kit is being carried in a motor trailer caravan, and they will sleep in tents on the demonstration ground.

# THE ROYAL AIR FORCE

*London Gazette*, March 15, 1932.
*General Duties Branch*

The follg. are granted short service comms. as Pilot Officers on probation with effect from and with seny. of the dates stated :—March 1 : W. H. Mitchell (Flying Officer, Auxiliary A.F.). March 4 : J. G. Davies, R. J. R. Docker, A. Franklin, P. K. Laing, M. C. Moore, J. J. Watts.

Pilot Officer on probation W. G. A. Coulson is confirmed in rank (March 13). The follg. Pilot Officers are promoted to rank of Flying Officer :—R. T. S. Morris (Oct. 16, 1931) ; H. N. G. Ramsbottom-Isherwood (Jan. 12) ; A. F. McKenna (Feb. 12) ; M. V. M. Clube (Feb. 27) ; A. R. Collins (Feb. 27). Flying Officer W. M. Rankin takes rank and precedence as if his appointment as Flying Officer bore date Jan. 7. Reduction takes effect from March 8. Flight Lieut. J. M. C. J. I. Rock de Besombes is placed on half-pay list, scale B, from March 8 to March 13 inclusive.

*Stores Branch*

Squadron Leader A. M. Saywood is placed on retired list (March 14).

*Legal Branch*

Flight Lieut. on probation W. I. Grantham, M.A., LL.B., is confirmed in rank (Feb. 16).

*Memorandum*

The permission granted to 2nd Lt. A. G. Palin to retain his rank is withdrawn on his conviction by the Civil Power (Jan. 5).

### ROYAL AIR FORCE RESERVE
### RESERVE OF AIR FORCE OFFICERS

*General Duties Branch*

Pilot Officer on probation W. S. Coates is confirmed in rank (Feb. 17) ; Pilot Officer R. A. D. Foster is promoted to rank of Flying Officer (Feb. 27) ; Flight Lieut. A. H. C. A. Rawson is transferred from Class C to Class A (March 8) ; Flight Lieut. J. H. Bentham is transferred from Class A to Class C (March 14) ; Flying Officer M. J. Wyatt, M.C., is transferred from Class B to Class C (Dec. 5, 1930) ; Flight Lieut. A. Haines relinquishes his commn. on account of ill-health (March 16).

*Medical Branch*

The follg. Flight Lieuts. relinquish their comms. on completion of service :—B. Pollard (Jan. 28) ; G. J. Griffiths (Feb. 11).

### AUXILIARY AIR FORCE

*General Duties Branch*

No. 602 (City of Glasgow) (Bomber) Squadron :—Flying Officer W. H. Mitchell relinquishes his commn. on appointment to a short service commn. in R.A.F. (March 1).

## ROYAL AIR FORCE INTELLIGENCE

**Appointments.**—The following appointments in the Royal Air Force are notified :—

*Wing Commanders :* K. C. Buss, O.B.E., to H.Q., R.A.F., Middle East, Cairo, 4.3.32, for Engineer Staff duties *vice* W/Commdr. F. H. Unwin, O.B.E. L. T. N. Gould, M.C., to No. 502 (Ulster) (B) Sqdn., Aldergrove, 5.3.32, to command *vice* W/Commdr. R. T. Leather, A.F.C.

*Squadron Leaders :* G. Y. Tyrrell, M.C., to H.Q., R.A.F., Middle East, Cairo, 4.3.32, for Air Staff (Photographic) duties, *vice* F./Lt. R. W. Hill. C. W. Mackey, to H.Q., R.A.F., Middle East, Cairo, 4.3.32, for Air Staff duties *vice* S/Ldr. A. Rowan. G. T. Richardson to No. 70 (B.T.) Sqdn., Hinaidi, Iraq, 4.3.32, for Flying duties *vice* S/Ldr. H. G. R. Malet.

*Flight Lieutenants :* W. E. James, to R.A.F. Base, Malta, 4.3.32. A. MacGregor, D.F.C., to No. 47(B) Sqdn., Khartoum, 4.3.32. J. L. Kirby, to No. 70 (B.T.) Sqdn., Hinaidi, Iraq, 4.3.32. T. H. Perry-Keene to R.A.F. Base, Malta, 4.3.32. G. Combe, to No. 30 (B) Sqdn., Mosul, Iraq, 4.3.32. A. L. R. Duke, to No. 1 Armoured Car Co., Hinaidi, Iraq, 4.3.32. L. J. Chandler, M.B.E., to H.Q., R.A.F., Iraq, Hinaidi, 4.3.32. L. T. Carruthers, to No. 55 (B) Sqdn., Hinaidi, Iraq, 4.3.32. J. L. F. Fuller-Good to No. 18 (B) Sqdn., Upper Heyford, 10.3.32.

*Flying Officers :* M. Griffiths, to No. 1 Armoured Car Co., Hinaidi, Iraq, 4.3.32. J. B. Knapp, to No. 58 (B) Sqdn., Worthy Down, 6.3.32. K. A. K. MacEwen, to No. 4 Flying Training Sch., Abu Sueir, Egypt, 4.3.32. F. Whittingham, to No. 30 (B) Sqdn., Mosul, Iraq, 4.3.32. C. A. Ball, to No. 4 Flying Training Sch., Abu Sueir, Egypt, 4.3.32. N. C. Hyde, to No. 208 (A.C.) Sqdn., Heliopolis, Egypt, 4.3.32. G. M. Gillan, to Armoured Car Section, Aden, 5.3.32. D. E. Milson, to No. 6 (B) Sqdn., Ismalia, Egypt, 4.3.32. H. T. Clark, to No. 208 (A.C.) Sqdn., Heliopolis, Egypt, 4.3.32. J. A. Hankins, to No. 208 (A.C.) Sqdn., Heliopolis, Egypt, 4.3.32. N. C. Hendrikz, to No. 208 (A.C.) Sqdn., Heliopolis, Egype, 4.3.32. L. H. Anderson, to No. 14 (B) Sqdn., Amman, Palestine, 4.3.32. R. C. W. Ellison, to Aircraft Depot, Karachi, India, 14.2.32. S. J. H. Carr, D.F.C., to Sch. of Naval Co-operation, Lee-on-Solent, 6.3.32.

*Pilot Officers :* G. R. Moorby, to No. 14 (B) Sqdn., Amman, Palestine, 4.3.32. W. S. Reed, to R.A.F. Depot, Aboukir, Egypt, 4.3.32. J. S. Sabine, to R.A.F. Depot, Aboukir, Egypt, 4.3.32. J. Goodhart, to No. 18 (B) Sqdn., Upper Heyford, 8.3.32. C. M. H. Outram, to No. 23 (F) Sqdn. Kenley, 8.3.32. J. W. Burgess, to No. 32 (F) Sqdn., Kenley, 8.3.32. L. F. J. Taylor, to No. 32 (F) Sqdn., Kenley, 8.3.32. M. D. C. Biggie, to No. 33 (F) Sqdn., Bicester, 8.3.32. T. G. Lovell-Gregg, to No. 41 (F) Sqdn., Northolt, 8.3.32. J. B. Sims, to No. 41 (F) Sqdn., Northolt, 8.3.32. R. C. Reynell, to No. 43 (F) Sqdn., Tangmere, 8.3.32. W. L. Houlbrook, to No. 56 (F) Sqdn., North Weald, 8.3.32. C. H. Mallinson, to No. 57 (B) Sqdn., Netheravon, 8.3.32. J. L. Armstrong, to No. 111 (F) Sqdn., Hornchurch, 8.3.32. F. A. Proctor, to No. 207 (B) Sqdn., Bircham Newton, 8.3.32. H. V. Horner, to No. 4 (A.C.) Sqdn., S. Farnborough, 8.3.32. C. N. Carpenter, to No. 4 (A.C.) Sqdn., S. Farnborough, 8.3.32. R. V. Bucknall, to No. 13 (A.C.) Sqdn., Netheravon, 8.3.32. J. G. G. Moore, to No. 13 (A.C.) Sqdn., Netheravon, 8.3.32. R. J. Twamley, to No. 26 (A.C.) Sqdn., Catterick, 8.3.32. A. H. Seymour-Lucas, to No. 26 (A.C.) Sqdn., Catterick, 8.3.32. J. J. A. Sutton, to No. 2 Flying Training Sch., Digby, 29.2.32. W. H. Mitchell, to No. 33 (B) Sqdn., Bicester, 1.3.32, on appointment to a Short Service Commn. as Pilot Officer (on probation). The undermentioned Pilot Officers are posted to the R.A.F. Depot, Uxbridge, on 4.3.32. on appointment to Short Service Commns. (on probation) :—J. G. Davies, R. J. R. Docker, A. Franklin, P. K. Laing, M. C. Moore, and J. J. Watts.

*Stores Branch.*

*Flight Lieutenants :* J. R. Brown, to No. 203 (F.B.) Sqdn., Basrah, Iraq, 4.3.32. C. P. Wingfield, to H.Q., Iraq Command, Hinaidi, 4.3.32.

*Flying Officer* F. G. Lee, to R.A.F. Depot, Aboukir, Egypt, 4.3.32.

### NAVAL APPOINTMENTS.

The following appointments have been made by the Admiralty :—

*Lieutenant Commanders :* R. A. Peyton (Flight Lieut. R.A.F.), reattached to R.A.F., and appointed to *Victory* for R.A.F. Base, Gosport.

*Lieutenant* R. A. Kilroy (F./O., R.AF.), to *Cornwall* (March 19).

### AIR MINISTRY NOTICES TO AIRMEN. SERIES A

**No. 11 of the year 1932. Flights Across the Strait of Dover. (47449/30.)**

With reference to N/A Series A, No. 6 of the year 1931, the motor-lifeboat stationed at Dover will not be in service during the next four weeks.

A fast motor-boat will be available, but radio communication with this boat will not be possible.

*March* 12, 1932.

**No. 12 of the year 1932. Night Flying Test by Pilots qualifying for "B" Licences. (151361/31.)**

Aircraft used for the above test should always in future be equipped with landing lights of approved type. This term includes wing tip flares.

The types of landing lights and flares approved at present for use on civil aircraft are as follow :—

(i) Philips landing lamp, manufactured by Philips Lamps, Ltd.
This lamp is approved subject to the proviso that an accumulator is fitted to obviate fading of the light caused by the aircraft losing speed. This equipment, complete with accumulators, may be obtained through Philips Lamps, Ltd., 145, Charing Cross Road, London, W.C.2, price approximately £55.

(ii) Holt Flare, Type H.10, manufactured by the Yorkshire Steel Co., Ltd., 30, Holborn, E.C.1. Cost per set complete, £10 15*s*. 6*d*.

The necessary amendments to the Air Navigation Directions to enforce this requirement will be promulgated in due course.

*March* 17, 1932.

**Air Pilotage Training**

In order to provide additional training for flying-boat pilots at Calshot, it has been decided to transfer the work of instruction in air pilotage to other stations. As a temporary measure, air pilotage training is now being provided by—(*a*) The Air Pilotage School, Andover. (*b*) Fighting Area Air Pilotage School, Northolt. The Air Pilotage School, Andover, will arrange two courses, each of 13 weeks' duration, during the period October to March, for the training of officers in air pilotage for the purpose of providing fully-qualified air pilotage officers for Wessex Bombing Area and other R.A.F. commands. The syllabus of this course, which will be included in Air Publication 874 in due course, will be similar to that of the air pilotage course previously given at Calshot. The Fighting Area Air Pilotage School, Northolt, will give short air pilotage courses of a fortnight's duration during the period October to March. These courses are intended for the training of pilots of Fighting Area and No. 1 Air Defence Group in the general principles of air pilotage for the benefit of units of Fighting Area and No. 1 Air Defence Group, whose establishment does not include the services of a fully-qualified air pilotage officer. The instruction thus obtained should take the place of that previously afforded by the air pilotage officers whose posts have been deleted from the establishments. These courses should not be confused with the longer courses held at Andover. In addition to the above-mentioned courses, short courses, of a fortnight's duration, are at present being continued at Calshot for senior officers, as required.

**The Royal Air Force Memorial Fund**

At the usual meeting of the Grants Sub-Committee of the above Fund, held at Iddesleigh House, on February 18, Mr. W. S. Field was in the chair, and the other members of the Committee present were :—Mrs. L. M. K. Pratt Barlow, O.B.E. ; Air Commodore B. C. H. Drew, C.M.G. ; Sqdn. Ldr. H. G. W. Lock. The committee considered in all 12 cases, and made grants to the amount of £153 12*s*.

At the meeting held on March 4, Mr. W. S. Field was in the chair, and the other members of the Committee present were :—Mrs. L. M. K. Pratt Barlow, O.B.E. ; Air Commodore B. C. H. Drew, C.M.G. ; Mrs. F. Vesey Holt ; Sqdn.-Ldr. H. G. W. Lock, D.F.C., A.F.C. The Committee considered in all 13 cases, and made grants to the amount of £252 18*s*. 9*d*.

**Women's Royal Air Force Reunion**

The ninth annual reunion dinner of the Women's Royal Air Force will be held at the Criterion Restaurant on Saturday, April 16. Air Marshal Sir W. Geoffrey Salmond, Air Officer Commanding-in-Chief, Air Defence of Great Britain, will be the principal guest. Other guests will include Colonel John Brown (Chairman of the British Legion), Mr. H. A. Jones (the Official Historian of the R.A.F.), and representatives of the Service Woman's Benevolent Fund, Queen Mary's Army Auxiliary Corps, the Women's Royal Naval Service, and the Ex-Service Women's Club. Dame Helen Gwynne Vaughan, Commandant of the W.R.A.F. and President of the W.R.A.F. Old Comrades' Association, will be in the chair. Other particulars may be obtained from the Secretary, W.R.A.F. Old Comrades' Association, Ex-Service Women's Club, 5, Buckingham Gate, S.W.1.

**Staff College, Quetta**

The undermentioned officer has completed satisfactorily the course at the Staff College, Quetta, which terminated in December, 1931, and is entitled to the letters "*q.s.*" after his name in the Air Force List :—Squadron Leader F. Fernihough, M.C.

# AIRCRAFT COMPANIES' STOCKS AND SHARES

THE stock and share markets have now shaken off the temporary uncertainty arising from the crisis affecting the Kreuger group of companies, and the tendency is for industrial shares to move in favour of holders. The further reduction in the Bank rate, the position of sterling and hopes that the Budget may give some relief in respect of taxation are factors which help to maintain a cheerful undertone. Shares of companies connected with the aircraft and allied industries have reflected the better market tendency. D. Napier & Son's ordinary, for instance, are 10½d. higher on the month at 4s. 7½d., despite the absence of a dividend for the past year and the decline in net profits from £169,905 to £21,562. No less than £58,670 of this decline is accounted for to meet depreciation in British Government securities as at September 30 last, when the company closed its year. No doubt much of this depreciation has since been recovered. The market was favourably impressed by the strong financial position again shown and by the decision to broaden the company's field of manufacture. Despite the cut in the dividend from 8 to 5 per cent., Vickers are 7s. 4½d., as against 8s. 6d. a month ago, and are now supported on any reaction presumably on the hope that the iron and steel industry will receive additional tariff benefits before long. A point of interest has been a gain of 1s. 3d. on the month by de Havilland, which are now quoted at 16s. 3d. following market reports that the company's business is increasing and an order for the supply of machines for the Brazilian Navy. Fairey Aviation have been steady around 15s.; a further increase in the dividend is being talked of in the market. Handley Page preference have been quiet; in some quarters there is considered to be the possibility that these shares will benefit from their participating rights in respect of the past year. Brown Brothers were marked up sharply from 22s. 6d. to 26s. 3d. on the good profits and the maintenance of the dividend for the past year. Imperial Airways have gained 1s. 3d. on the month on hopes that traffics will continue to grow and on the possibility that the company is in a better position to compete for traffic than a year ago owing to the lower external value of the pound sterling. Rolls-Royce show an advance of nearly 5s. on the month; the results which show a decline of less than £3,000 in profits confirm the hope mentioned here last month that the distribution would be maintained at 10 per cent. A statement is expected at the meeting regarding the future of Bentley Motors which the company acquired late last year. Ford Motor continued to lose ground on persistent talk of a large cut in the dividend. Joseph Lucas put on 1s. 3d. on the expectation that the interim dividend will be maintained. Business around 2½d. has been recorded in National Flying Services since the issue of the report.

| Name. | Class. | Nominal Amount of Share. | Last Annual Dividend. % | Current Week's Quotation. |
|---|---|---|---|---|
| Anglo-American Oil .. .. | Deb. | Stk. | 5½ | 99½ |
| Armstrong Siddeley Develop. | Cum. Pref. | £1 | 6½ | 12/6 |
| Birmingham Aluminium Castg. | Ord. | £1 | 5 | 19/6 |
| Booth (James), 1915 .. .. | Ord. | £1 | 15 | 43/6 |
| Do. do. .. .. | Cum. Pref. | £1 | 7 | 22/- |
| British Aluminium .. .. | Ord. | £1 | 5 | 25/- |
| Do. do. .. .. | Cum. Pref. | £1 | 6 | 20/- |
| British Celanese .. .. | Ord. | 10/- | Nil | 8/6 |
| British Oxygen .. .. | Ord. | £1 | 8B | 11/10½ |
| Do. do. .. .. | Cum.Pref. | £1 | 6½ | 16/3 |
| British Piston Ring .. .. | Ord. | £1 | 10 | 25/- |
| British Thomson-Houston .. | Cum. Pref. | £1 | 7 | 23/- |
| Brown Brothers .. .. | Ord. | £1 | 10 | 26/3 |
| Do. do. .. .. | Cum. Pref. | £1 | 7½ | 22/6 |
| Dick (W. B.) .. .. .. | Cum. Pref. | £10 | 5 | 112/6 |
| De Havilland Aircraft .. | Ord. | £1 | 5 | 16/3 |
| Dunlop Rubber .. .. | Ord. | C | 6 | 11/3 |
| Do. do. .. .. | "C" Cum.Pref. | 16/- | 10 | 11/10½ |
| En-Tout-Cas (Syston) .. .. | Def. Ord. | 1/- | Nil | 1/- |
| Do. do. .. .. | Ptg. Pfd. Ord. | 5/- | 8 | 1/10½ |
| Fairey Aviation .. .. | Ord. | 10/- | 10* | 15/1½ |
| Do. do. .. .. | 1st Mt. Deb. | Stk. | 8 | 105 |
| Firth (T.) & John Brown .. | Cum. Pref. | £1 | 6D | 8/6 |
| Do. do. .. | Cum. Pref. | £1 | 5*D | 8/- |
| Ford Motor (England) .. | Ord. | £1 | 10 | 23/9 |
| Fox (Samuel) .. .. .. | Mt. Ptual. Deb. | Stk. | 5 | 72½ |
| Goodyear Tyre & Rubber .. | Deb. | Stk. | 6½ | 97½ |
| Handley Page .. .. .. | Ptg. Pref. | 8/- | 12½ | 10/6 |
| Hoffmann Manufacturing .. | Ord. | £1 | Nil | 15/1½ |
| Do. do. .. | Cum. Pref. | £1 | 7½ | 13/9 |
| Imperial Airways .. .. | Ord. | £1 | 3 | 14/9 |
| Kayser, Ellison .. .. | Ord. | £5 | Nil | 55/- |
| Do. do. .. .. | Cum. Pref. | £5 | 6 | 75/- |
| Lucas (Joseph) .. .. | Ord. | £1 | 20 | 61/3 |
| Napier (D.), & Son .. .. | Ord. | 5/- | Nil | 4/7½ |
| Do. do. .. .. | Cum. Pref. | £1 | 7½ | 18/9 |
| Do. do. .. .. | Pref. | £1 | 8 | 16/10½ |
| National Flying Services .. | Ord. | 2/- | Nil | -/2½ |
| Petters .. .. .. .. | Ord. | £1 | 6 | 17/6 |
| Do. .. .. .. .. | Cum. Pref. | £1 | 7½ | 17/6 |
| Roe (A.V.) (Cont. by Armstrong-Siddeley Devel., *q.v.*) | Ord. | £1 | — | — |
| Rolls-Royce .. .. .. | Ord. | £1 | 10 | 35/- |
| Smith (S.) & Sons (M.A.) .. | Def. Ord. | 1/- | Nil | 1/6 |
| Do. do. .. | Ptg. Pfd. Ord. | £1 | 7 | 12/6 |
| Do. do. .. | Cum. Pref. | £1 | 7½ | 15/- |
| Serck Radiators .. .. | Ord. | £1 | 15 | 30/- |
| "Shell" Transport & Trading | Ord. | £1 | 17½* | 39/4½ |
| Do. do. .. | Cum. Pref. | £10 | 5 | £9½ |
| Triplex Safety Glass .. .. | Ord. | £1 | 10 | 34/- |
| Vickers .. .. .. .. | Ord. | 6/8 | 5 | 7/4½ |
| Do. .. .. .. .. | Cum. Pref. | £1 | 5* | 17/9 |
| Vickers Aviation (Cont. by Vickers, *q.v.*) .. .. .. | — | — | — | — |
| Westland Aircraft (Branch of Petters, *q.v.*) .. .. .. | — | — | — | — |
| Whitehall Electric Investmts. | Cum. Pref. | £1 | 7½ | 22/- |

*Dividend paid tax free. B Rate per annum for nine months. C £1 unit of stock. D Last xd. on March 19, 1931.

## PUBLICATIONS RECEIVED

*U.S. National Advisory Committee for Aeronautics Reports:* No. 393, *Span-Load Distribution as a Factor in Stability in Roll.* By M. Knight and R. W. Noyes. Price 10 cents. No. 396, *Hydraulics of Fuel Injection Pumps for Compression-Ignition Engines.* By A. M. Rothrock. Price 25 cents. No. 398, *Investigation of Damping Liquids for Aircraft Instruments—II.* By M. R. Houseman and G. H. Keulegan. Price 15 cents. No. 400, *The Aerodynamic Characteristics of a Slotted Clark Y Wing as Affected by the Auxiliary Aerofoil Position.* By C. J. Wenzinger and J. A. Shortal. Price 15 cents. Superintendent of Documents, Washington, D.C., U.S.A.

*Lubricating Oil Tests and Their Significance.* By J. E. Southcombe. Henry Wells Oil Co., Ltd., Salford, Manchester. Price 2s. 6d.

*Abyssinia, 1929-31. An Aero-Philatelic Guide.* By N. C. Baldwin. Francis J. Field, Ltd., Sutton Coldfield. Price 9d.

*British Legion Annual Report and Accounts, 1930-31.* British Legion, 26, Eccleston Square, London, S.W.1.

## AERONAUTICAL PATENT SPECIFICATIONS

(*Abbreviations*: Cyl. = cylinder; i.c. = internal combustion; m. = motors
The numbers in brackets are those under which the Specification will be printed and abridged, etc.)

### APPLIED FOR IN 1930

*Published March 24, 1932.*

24,793. ALUMINIUM, LTD. Screw propellers. (367,791.)
25,689. ALUMINIUM, LTD. Screw propellers. (367,868.)
28,019. BRAITHWAITE & CO., ENGINEERS, LTD., J. C. TELFORD and J. HINES. Manufacture of aerodromes and like surfaces. (367,766.)
31,746. VICKERS-ARMSTONGS, LTD., and B. W. A. DICKSON. Aircraft gun-mountings of the spring-balanced ring type. (367,845.)
32,382. G. DE GASENKO. Hydroplanes or the like. (367,875.)
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